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DEPARTAMENTO DE PRODUCCIÓN AGRARIA

COOPERATION PROJECT FOR DON BOSCO TECHNICAL SCHOOL: TRANSFORMATION AND START UP OF A 30 HA HORTICULTURAL EXPLOITATION IN GAMBELLA, ETHIOPIA.

TRABAJO FIN DE GRADO

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DOCUMENT 1: MEMORY AND REPORTING TO MEMORY

Sebastián Sangro Lucas

MEMORY INDEX

1. PURPOSE OF THE PROJECT

1.1. Nature of transformation

The transformation of a wild plot into a horticultural farm will be carried out within the framework of the agricultural vocational training course provided by Don Bosco Technical School in Gambella, Ethiopia.

This project is written in order to start up this transformation and to put in an easily manageable document all the information related to the start-up and management of the horticultural exploitation. The activity and the productive means necessary to carry it out are defined, considering not only the didactic and productive purpose of the farm, but also the environmental and socio-economic conditions of the region.

This report synthesizes the main aspects of the project. The detailed descriptions and justifications of the decisions taken are found in the Attachments to the Report.

1.2. Location and size of the farm

The farm subject to the transformation has an area of 60 ha, of which 30ha will be the subject of this transformation. It is located 12 km south from Gambella city. This city lies 700 km west of Addis Ababa, the capital of Ethiopia, and the Gambella region borders South Sudan on its west side. The farm borders on the north side with small unmarked plots belonging to members of the Anuak tribe settled in the area. To the east is an unpaved road, which leads from the paved road to the river and runs along the edge of the estate. To the south, the estate delimits with the asphalted road that takes from Gambella to Addis Ababa. To the west, the limit is given by a tributary of the Baro river, which is dry for six months every year.

Figure 1: Project location. Left: Gambella region in Ethiopia. Right: Location of the plot and school in Gambella. (Source: Google Maps)

Image 1: Aerial view of the farm. (Source: Google Earth and Measure Map)

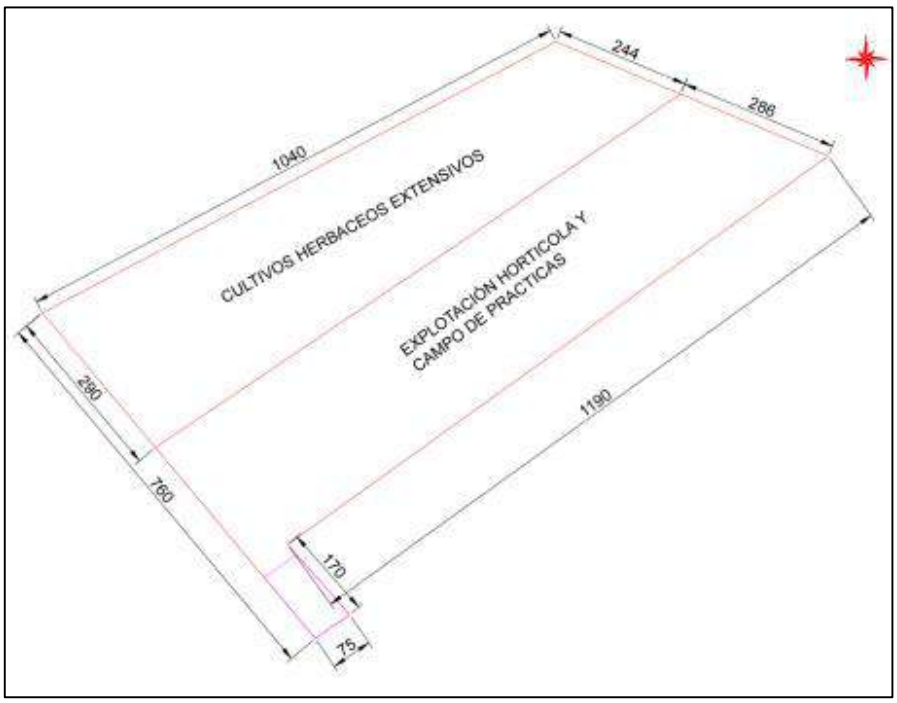


Figure 2: Scheme division of the farm

The geographical coordinates are: 8º 10 '20.84' 'North - 34º 39' 26.51 '' Est, in decimal degrees 8.172455, 34.657364, and in UTM coordinates X-674028,291, Y-912280,285 and Use 36P

2. PROJECT MOTIVATIONS AND GUIDELINES

2.1. Motivation

Don Bosco school is willing to take advantage of the opportunity provided by the local government with the granting of exploitation rights to the farm, so they can improve life quality among the local community, increase family income in the area, improve population's nutrition and promote sustainable agricultural practices.
The best way to fulfill this desire is to create a vocational training course whose practices will be taught in this field. In addition, the farm will provide food to the school and incomes to maintain the courses and the exploitation.

2.2. Purpose

The purpose of the transformation is the profitable production of vegetables for the supply of the school and for the sale in the local market. In addition, the orchard has a didactic purpose for students of vocational training.

2.3. Conditions imposed by the promoter

The school Don Bosco establishes as a conditioner the production of vegetables. In addition, production must be constant throughout the year and as versatile as possible, in order to cope with the changing needs of the local population.

3. ANALYSIS AND DIAGNOSIS OF THE DEPARTURE SITUATION

3.1. Background and Conditions

3.1.1. Legal

-Proclamation for the development and conservation of apiculture resources (Apiculture resources development and protection No. 660/2009)

- Proclamation for seed control (Seed proclamation No. 206/2000)

- Proclamation for the Improvement of the National Seed Industry Agency (Proclamation to amend the National Seed Industry Agency No. 122/1998)

-Proclamation for the conservation, development and use of forests (Proclamation to provide for the conservation, development and utilization of forests No. 94/1994)

-Proclamation to provide access to genetic resources, and access to information on community rights and knowledge (Proclamation to provide access to genetic resources and community knowledge and community rights No. 482/2006)

-Proclamation on the rights of genetic improvers (Plant breeders' right proclamation No. 481/2006)

-Proclamation on labor rights (Labor Proclamation No. 377/2003)

3.1.2. Of horticultural implantation in Gambella

The land of the estate has never been exploited for what it is a completely virgin land, with abundant arboreal vegetation and herbaceous plants mostly monocotyledons. It is a savanna forest of acacias and other leguminous species inhabiting numerous animal species of high environmental value such as some species of protected birds. The property is not delimited and there is no sign that it is a private property.

Image 2: A clear area within the estate. (Author: Sebastián Sangro Lucas)

Image 3: Colobo monkey (Colobus guereza Rüppell.) in the farm. The sighting of animals in the plot is usual. (Author: Sebastián Sangro Lucas)

On the other hand, in Gambella can be found four types of farms that can be distinguished by their size:

-The largest, owned by multinationals and can reach thousands of hectares and are dedicated to monoculture or "cashcrop" (cash crops, a term used to refer to this type of farms or crops).

-The farms of NGOs and parishes that are between 50 and 150 hectares in size and in which a little of everything is cultivated. These are the only farms that have irrigation in the region and devote part of their land to the cultivation of vegetables.

-The plots of "highlanders" (Ethiopians from other regions), of between one and two hectares and in which ocra, maize, chilli, sesame and others are grown, but without reaching the diversity of the previous ones.

- The plots of members of local tribes. The latter, as explained below in socio-economic antecedents and conditions, are the least technified because these tribes are pastoral nomadic tradition and have been forced to settle in a relatively short period of time. They usually do not have more than one hectare and only maize is grown for their own consumption, and in rare cases, for the sale of corn flour in a walking fashion.

Image 4: A typical single family dwelling of the local tribes near the estate. Behind you can appreciate the corn crops of the family. (Author: Sebastián Sangro Lucas)

The lack of horticultural crops is reflected in the origin of local market products. 100% of the vegetables that can be found in Gambella are imported from other regions or countries (the selling of surpluses is not counted). Due to this, to the precarious conditions and to the fact that agriculture in Gambella is relatively new, no data of horticultural crop production nor projects in similar conditions have been found.

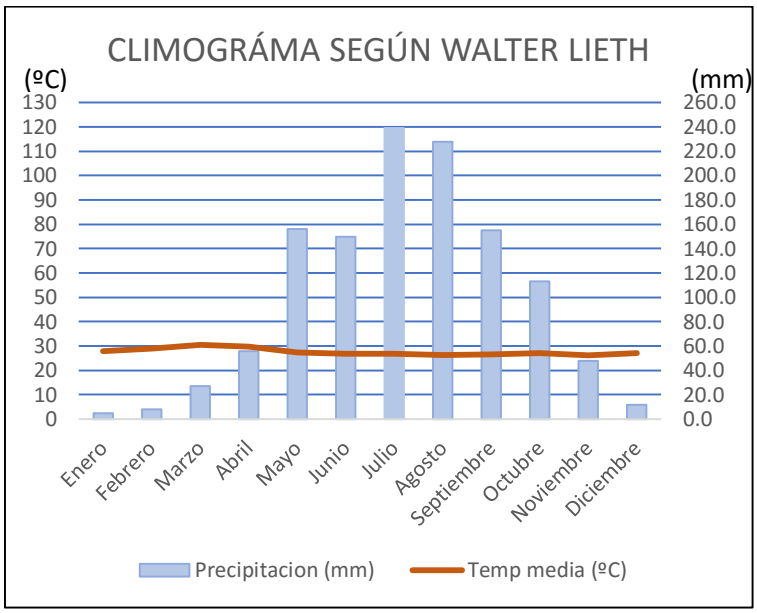
3.1.3. Climatology

Data for climate analysis were obtained from the FAO database through its ClimWat program for CropWat. The nearest station to the land is Gambella station, 12 km north of the farm, and at the same altitude. The data include maximum and minimum temperatures, relative humidity, hours of sunshine daily, radiation, wind speed, ETPo according to Penman-Monteith, precipitation and effective precipitation.

Table 1: Data station of Gambella. (Source: FAO)

PAÍS	Etiopía
REGIÓN	Gambella
WOREDA	Gambella
SUBCUENCA	Baro-Akobo
CUENCA	Nilo
COORDENADAS UTM X	674028,291
COORDENADAS UTM Y	912280,285
HUSO	36P
COORDENADAS G.M.S.s	08°14'60,0"N 34°34'48,0"E
ALTITUD (msnm)	480
SERIE DE DATOS	15 años

In these latitudes, with tropical and equatorial climates, the main condition for agricultural production is the seasonality of the rains and the high temperatures of the months of April and early May. The tropical rain belt reaches Gambella in early May and does not return to the southern hemisphere until last October. During the months of November to April, there may be months where not a single drop falls, and most rivers dry up, but not the Baro River which maintains a significant flow throughout the year. In addition, more than a third of annual rainfall falls during the months of July and August in a torrential manner causing serious problems in crops and even in vulnerable populations.



Graphic 1: Climatic according to Walter Lieth. (Own elaboration)

The average annual rainfall is around 1200 mm and temperatures are between 20 and 35 ° C throughout the year.

Gorczinski's continental index, 30.54> 30, indicates that the land is located in a very continental area.

According to the **Lang aridity index**, 40 <**43.32** <60, this is a zone of wetlands of steppe and savanna and according to the aridity index of Martonne, 30 <31,83 <60 is a wet zone.

According to the **UNESCO-FAO aridity criterion**, Gambella is a sub-humid region, with 4 dry months (less than 30 mm) between December and March inclusive, and the maximum dry season in winter.

The **potential forest productivity index** indicates that it is an unrestricted area for the growth of productive forests with an estimated potential production of **7.65 m3 / ha.year**. The **agricultural potential index of Turc** establishes a potential production of **43.86 t / ha.year in irrigation and 25.26 t / ha.year in rainfed**.

The different climate classifications summarize the climatic data according to the temperature and precipitation regimes. According to the **classification of Köppen**, it is a climate of Group A (Rainy Tropical) Subgroup w (dry winter). According to **UNESCO-FAO,** the terrain is in an area of climatic group 1, warm subgroup, equatorial warm-axic subdivision. **Papadakis agroclimatic classification** is especially suitable for agricultural projects and in this case, indicate that it is an area with Equatorial Winter, free of frost, and Summer Gossypium (G). The **thermal regime** according to the same classification is Equatorial Warm, and the water regime is Monsoon.

Finally, it is possible to emphasize the role that the meteorological phenomenon of El Niño is having in the severe droughts that are desolating the country. It is a phenomenon that is not fully understood, but above all, that can not be foreseen, so it is essential to create a resilient project, capable of facing the profound changes caused by this phenomenon, not only in nature, but also in the Ethiopian economy and society.

3.1.4. Edaphology

According to the data obtained from the soil analysis of the ISRIC (International Soil Reference and Information Center), the land of the farm is loamy clay texture, with a pH around 6.5, with an optimum amount of organic matter and nutrients and high water retention capacity.

According to the Atlas of Soils of Africa (SAA) the soil of the land belongs to the group of Alisols although it is likely to be several others such as Nitisols, Vertisols, Leptosols and Inceptisols as they all concur at this point on the map.

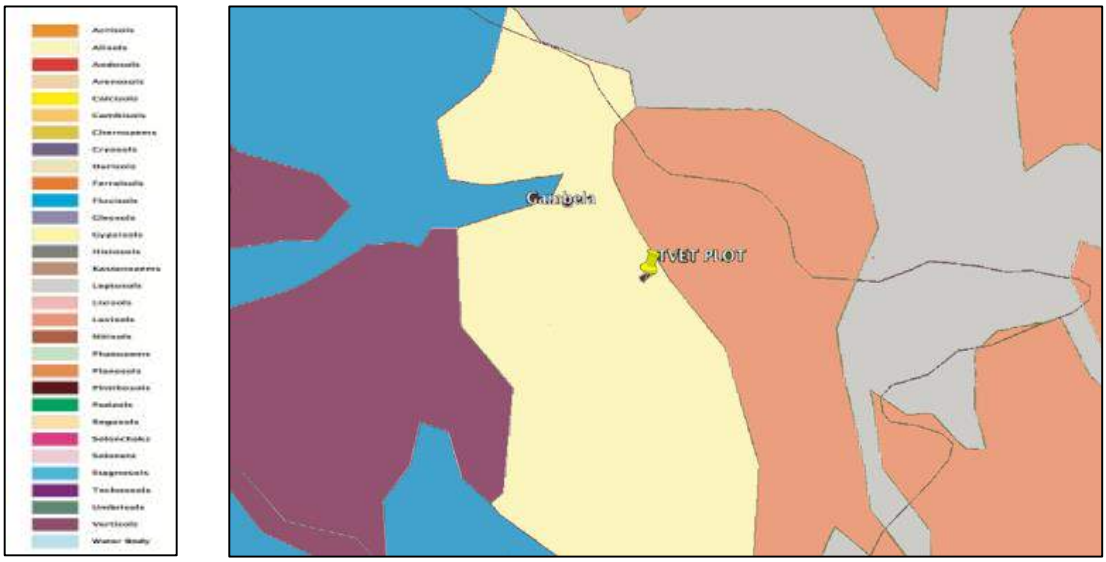


Figure 3: Map of soils of the study area and legend. (Source: Soil Atlas of Africa)

As explained below in the Background and Conditions annex, the soil clay content of the farm is relatively high. It is usual that, in this type of soils, due to the high proportion of clay, problems related to the handling occur. On the one hand, expansive clays create cracks when they are dried or pumped when they get wet, seriously influencing the infiltration of water into the soil. On the other hand, they are floors that go from being very hard when they are dry, to being too plastic when they get wet, and this happens with a minimum amount of water, reason why the use of machinery is limited by the difficulty of obtaining a floor In good seasoning.

Finally, it is important to emphasize the importance of the soils, having been the year 2015 the international year of the soils. One of the objectives derived from this project is the conservation of this resource in relation to erosion and loss of biodiversity. It is assumed that a high biodiversity in the soil favors the absorption of nutrients by the crops with which it can increase the production. In order to maintain this diversity, it is necessary to maintain a healthy population of trees, at the edges of the farm and at the edges of the roads, especially of legumes, since in addition to favoring the expansion of fungi and bacteria in deep areas of the soil, Fix nitrogen.

The following table shows the physical-chemical and soil fertility properties:

Table 2:Physical-chemical and soil fertility properties. (Own elaboration)

PROFUNDIDAD(cm)/ PROPIEDADES	0	5	15	30	60	100	200
ARCILLA (%)	31	29	31	35	38	38	38
LIMO (%)	25	26	25	24	24	23	23
ARENA (%)	44	45	44	41	38	38	39
CLASE TEXTURAL (USDA)	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA

ELEMENTOS GRUESOS (%)	12	12	13	15	17	19	23
DIAGNOSTICO E.G.	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
DENSIDAD APARENTE (t/m3)	1,3	1,3	1,3	1,3	1,3	1,3	1,3
ENCOSTRAMIENTO	Sin riesgo	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx
COMPACTADO	No	No	No	No	No	No	No
Carbón orgánico (g/kg)	41	19	16	9	6	5	6
Materia Orgánica (%)	7,1	3,3	2,8	1,5	1,0	0,9	1,0
DIAGNOSTICO M.O.	Excesivo	Rico	Correcto	Muy pobre	Muy pobre	Muy pobre	Muy pobre
PM (cm^3/cm^3) Calculado	0,292	0,223	0,224	0,225	0,232	0,230	0,232
PM (cm^3/cm^3) Grafico	23	22	23	24	25	24	24
CC (cm^3/cm^3)	0,492	0,370	0,363	0,348	0,349	0,344	0,347
CRAD (cm^3/cm^3)	0,200	0,147	0,139	0,122	0,117	0,115	0,115
DIAGNOSTICO CRAD	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable
CIC (cmolc/kg)	15	15	16	16	16	16	16
DIAGNOSTICO CIC	Normal	Normal	Normal	Normal	Normal	Normal	Normal
N (%)	xxxxx	xxxxx	0,1	xxxxx	0,06	xxxxx	xxxxx
Relación C/N	xxxxx	xxxxx	16	xxxxx	10	xxxxx	xxxxx
DIAGNOSTICO C/N	xxxxx	xxxxx	Muy alta	xxxxx	Ligeramente alta	xxxxx	xxxxx
Na+(cmol/kg)	xxxxx	xxxxx	0	xxxxx	0,1	xxxxx	xxxxx
PSI (%)	xxxxx	xxxxx	0	xxxxx	0,625	xxxxx	xxxxx
DIAGNOSTICO PSI	xxxxx	xxxxx	No salino	xxxxx	No salino	xxxxx	xxxxx
Ca2+(cmolc/kg)	xxxxx	xxxxx	3,6	xxxxx	3	xxxxx	xxxxx
DIAGNOSTICO Ca2+	xxxxx	xxxxx	Bajo	xxxxx	Bajo	xxxxx	xxxxx
Mg2+(cmolc/kg)	xxxxx	xxxxx	2,5	xxxxx	2,5	xxxxx	xxxxx
DIAGNOSTICO Mg2+	xxxxx	xxxxx	Excesivo	xxxxx	Excesivo	xxxxx	xxxxx
K+(cmolc/kg)	xxxxx	xxxxx	0,4	xxxxx	0,3	xxxxx	xxxxx
DIAGNOSTICO K+	xxxxx	xxxxx	Correcto	xxxxx	Correcto	xxxxx	xxxxx
V(%)	xxxxx	xxxxx	40,6	xxxxx	36,9	xxxxx	xxxxx
DIAGNOSTICO V(%)	xxxxx	xxxxx	Desfavorable	xxxxx	Desfavorable	xxxxx	xxxxx
SAR((mmolL)1/2)	xxxxx	xxxxx	0	xxxxx	1,21	xxxxx	xxxxx
DIAGNOSTICO SAR	xxxxx	xxxxx	No salino	xxxxx	No salino	xxxxx	xxxxx

3.1.5. Irrigation wáter

Irrigation water is obtained directly from the Baro River which is located 100 m from the horticultural exploitation. The river Baro is important throughout the year, and its waters come from the mountains located 250 km north of Gambella so they are naturally low salt waters. According to the chemical analysis carried out by the Initiative for the Nile River Basin, it is a very cloudy water due to a high concentration of clay particles in suspension, and the concentration of iron and manganese. On the other hand, low salinity and SAR, less than 10, and the low electrical conductivity and total dissolved solids, allow the use of this water for irrigation and even for human consumption after treatment. Finally, the low concentration of nitrates and nitrites, less than 10 mg / L and 0.4 mg / L respectively, indicates that in 2001 the Baro River was not contaminated by anthropological activities such as the chemical industry or intensive agriculture .

3.1.6. Socio-economic

In recent years Ethiopia has experienced a growth of 7%, which is considered one of the largest in the world during the 2008-2016 season. With this, the country has invested, along with its Chinese partner, in infrastructures such as trains, trams, roads and dams. Yet with a per capita income of $ 1,300 a year, Ethiopia must make great efforts to improve the quality of life of its population, estimated at 96.6 million. The agricultural sector represents 47% of GDP, and occupies 85% of the workforce in the country. Agriculture is very little technified and the techniques used in most cases are archaic. (World Bank Data, 2015)

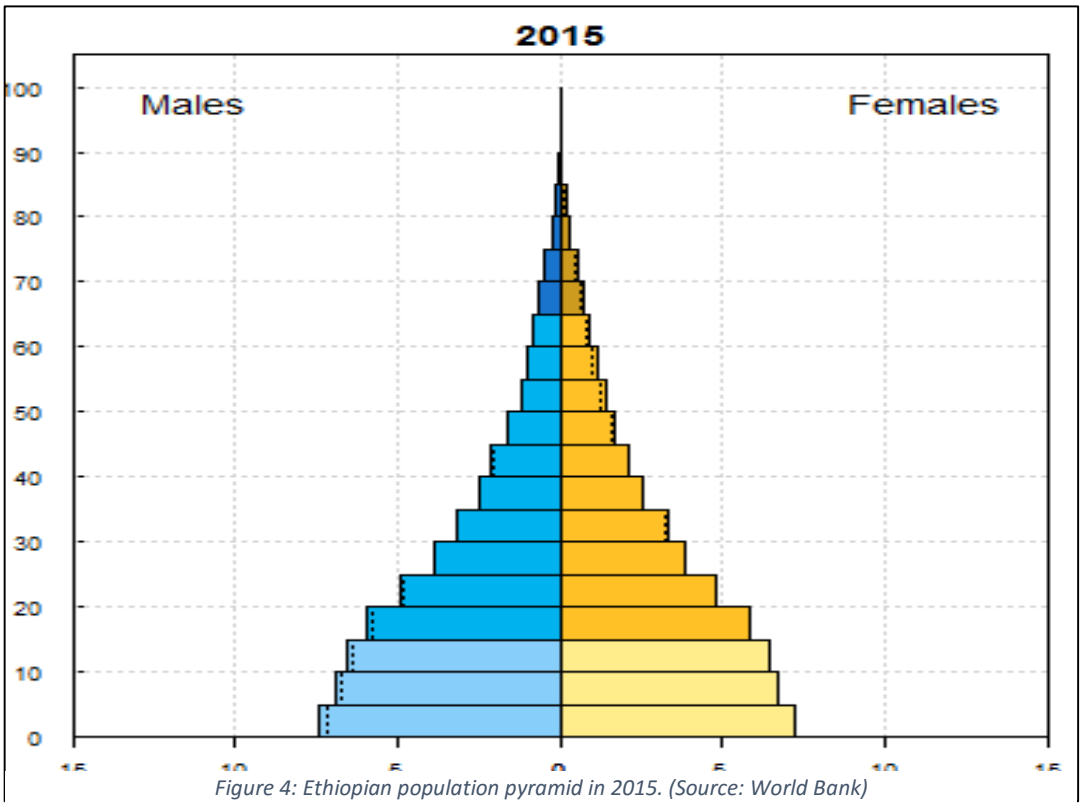


Figure 4: Ethiopian population pyramid in 2015. (Source: World Bank)

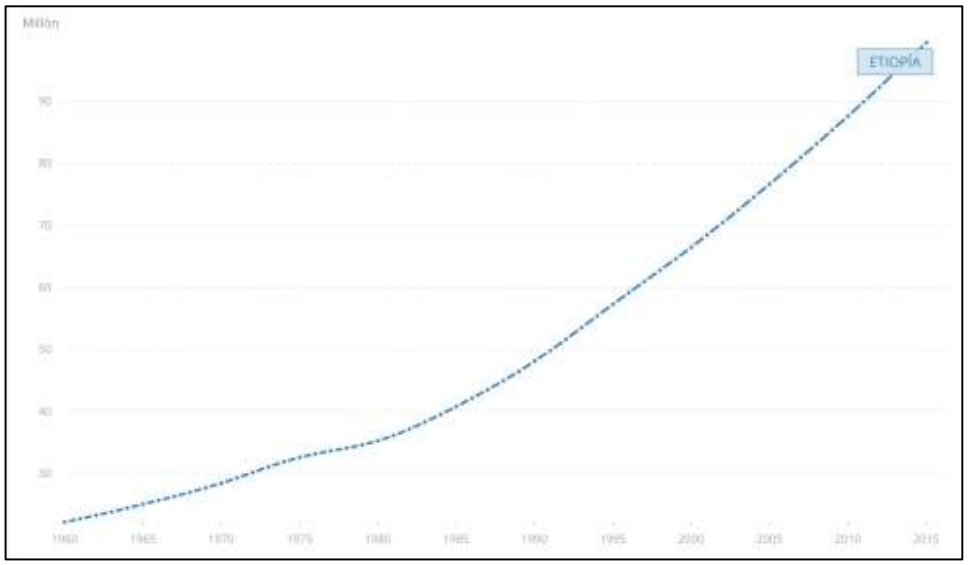


Figure 5: Population growth in Ethiopia since 1960. (Source: World Bank)

Within the wide range of ethnicities and tribes and Ethiopian nationalities, the region of Gambella is undoubtedly the most different, not only by its orography but by its inhabitants, whose language has a Nilo-Saharan origin, completely different from the rest of Ethiopians , Of Semitic origin. With 29 782.82 km2, it is the smallest region of Ethiopia (excluding the autonomous cities of Addis-Ababa, Harar and Dire Dawa) and is mostly occupied by Gambella National Park. However, it is the region with the least inhabitants per square kilometer with 10 inhabitants / km2 and a total population of approximately 300,000 according to the 2007 census. The capital is located to the north of the region and is connected to Addis Ababa (700 km , Two days by car) by a single asphalted road that passes through the towns of Bedele and Jima (300 km and 350 km respectively, a day by car). In the opposite direction is the city of Dembi Dolo (100 km) and the border with South Sudan (90 km) also with asphalted roads.

It is necessary to distinguish the tribes present in Gambella since not all have the same level of agricultural knowledge. There are two main groups:

- The "highlanders", which means mountaineer in English and refers to the fact that they come from the mountains, since Gambella is much lower than the rest of Ethiopia. These are subdivided into tribes, all originating from other regions and all of Semitic origin. They were brought to Gambella by force by the government of the Derg (communist government, 1975-1987) during the process called "villagization" (aldeización in English) and settled until today.
- The local tribes, of which they emphasize the Nuer, the Anuak and the Mezenguer. These are of Nilo-Saharan origin (concretely nilotic) and do not understand the Semitic languages (Afro-Asians and omóticos) as well as the "highlanders" and vice versa.

In the following table you can see the number of inhabitants per tribe and its language:

Table 3: Populations, tribes and ethnicities of Gambella. (Source: www.csa.gov.et)

ETNIA/TRIBU/GRUPO	POBLACION	% DEL TOTAL	IDIOMA
NUER	134640	44	NILÓTICO
HIGHLANDERS:	74694,6	24,41	
AMHARA	25765,2	8,42	AFRO ASIATICO
OROMO	14779,8	4,83	AFRO ASIATICO
KEFFA	12546	4,1	OMÓTICO
MOCHA	6120	2	OMÓTICO
KAMBAATA	4406,4	1,44	AFRO ASIATICO
SAKACHO	7038	2,3	OMÓTICO
TIGRAY	4039,2	1,32	AFRO ASIATICO
ANUAK	64260	21	NILÓTICO
MEZHENGER	11628	3,8	NILÓTICO
APANA	20777,4	6,79	NILÓTICO
KOMO			NILÓTICO
MURLE			NILÓTICO
OTROS			
TOTAL	306000	100	
REFUGIADOS (Mayoría Nuer)	300.000		NILÓTICO
TOTAL+REFUGIADOS	606000		

Agriculture practiced by local tribes is very different from the rest of the country. It is based on an extensive nomadic cattle ranch, reason why agriculture is something new and unknown for the majority of the inhabitants. This fact does not have data on the number of small farms, nor on average productions in the region.

On the other hand, large multinationals have bought vast tracts of land, such as Saudi Star, which has more than 500,000 hectares throughout the country, 100,000ha in Gambella, of which only 10.000 ha are exploited at present. It should be noted that the average size of the plots that exploit the inhabitants of the region is between half a hectare and two hectares. This difference between small farmers and large companies requires intervention to improve the farming techniques used by farmers in the region and to promote good agricultural practices in order to maintain a reasonable production in the long term. This has to be done in view of Gambella's complex social landscape: a mosaic of tribes, some local, and others from elsewhere, often forced by war, as is the case of the approximately 300,000 refugees that this region. In addition, it has no industry, no exports of goods (if MNCs are not taken into account), and it is obliged to import everything, including basic foodstuffs, so that it would benefit enormously from improved agriculture.

3.2. Current situation

The farm, with a total of 60ha, was ceded two years ago by the local government for an indefinite period to carry out the professional training practices in agriculture. It is a virgin land, in disuse until now, with savanna forest that has never been used as an agricultural operation and inhabited by innumerable animal and plant species. Only in the parts near the river, up to a hundred meters from the shore, are settled Anuak communities that cultivate maize (monoculture) in the rainy season. These communities use the forest resources of the farm, including wood, coal, honey, tubers and medicinal and aromatic plants, fruits, game and others.

On the other hand, the school, located in the city of Gambella, has a total of 800 students divided between courses 1 and 12 that correspond to the years of schooling, which runs from 6 years to 18 years and in The four branches of vocational training provided by the center, mechanics, woodwork, metalwork and secretary. In addition, the school has a library, a conference hall, several sports courts, a residence, a church, a soccer field, a coffee shop and a new aulario is being built due to the great demand by the local population.

3.3. Future situation "without project"

Without the realization of the project the terrain will remain in disuse and consequently the right of exploitation will be withdrawn by the local government. If that happens the vocational school will not be able to teach the course of agriculture and all the efforts and investments made to date to create it will have been in vain.
On the other hand, the land can continue as this, ie virgin, or be ceded to another organization that carries out a social work in the field of agriculture, or in the worst case, can be rented to a multinational.

4. STRATEGIC ALTERNATIVES

4.1. Choice of cultivated species

An analysis of 41 horticultural species has been carried out to choose the ones that are best adapted to the environment, not only to the physical one, but also to the socio-economic one. The factors analyzed for each species were: [1] -Adaptation to the climate, [2] -Adaptation to the soil, [3] -Management, [4] - Local acceptance and market, [5] - Nutritive properties, [6] - Conservation, [7] -During the crop. In addition, each factor was weighted according to its importance for the development of the project: 1 factors [1] and [7], 0,75 factors [2], [4] and [6], 0, 5 factors [3] and [5].

The final result is a ranking of species that best adapt according to the previous factors, weighted by their importance, along with a note about 10 that gives us an idea of the difference between species in the ranking. With him, the operator can choose the crops that best adapt to the climate and soil, or the best outlet in the market, and thus balance between profitability and safety in each cycle since the availability of vegetables In the

market and therefore their prices are very volatile, what today is a profitable crop can stop being it in a very short space of time.

Table 4: Ranking of species for the project. (Own elaboration)

Scientific name	Crop / Characteristics (coefficient)	[1] 1	[2] 0,75	[3] 0,5	[4] 0,75	[5] 0,5	[6] 0,75	[7] 1	Total	Score from 0 to 10
Arachis hypogaea L.	Peanut	5	4	5	5	5	5	5	25,5	9,7
Cicer arietinum L.	Chickpeas	5	5	5	4	5	5	5	25,5	9,7
Ipomoea batatas Lam.	Sweet potato	5	4	5	4	4	5	5	24,25	9,2
Cucumis melo L.	Cantaloupe	5	5	5	3	3	5	5	23,75	9,0
Brassica oleracea L.	Cabbage	5	5	5	5	3	3	5	23,75	9,0
Cucurbita maxima Duchesne	pumpkin	5	4	5	4	2	5	5	23,25	8,9
Abelmoschus esculentus L.	Okra	5	5	5	5	3	1	5	22,25	8,5
Citrullus lanatus Thumb.	Watermelon	5	5	5	3	3	3	5	22,25	8,5
Cymbopogon citratus (DC.) Stapf	Lemon grass	5	5	5	1	3	5	5	22,25	8,5
Allium cepa L.	Onion	4	4	5	5	3	5	3	21,5	8,2
Lycopersicon esculentum Mill.	Tomato	5	5	3	4	4	1	5	21	8,0
Vicia faba L.	Bean	1	4	5	4	5	5	5	20,75	7,9
Zingiber officinale Rosc.	Ginger	5	2,5	5	4	3	5	3	20,625	7,9
Beta vulgaris L. *var. conditiva* Alef.	Beet	2,5	2,5	5	4	4	5	5	20,625	7,9
Capsicum annuum L.	Peppers	4	4	5	5	3	1	5	20,5	7,8
Colocasia esculenta (L.) Schott	Taro	5	4	5	1	5	5	3	20,5	7,8
Cyperus esculentus L.	Tiger nut	4	2,5	5	1	5	5	5	20,375	7,8
Solanum melongena L.	Eggplant	5	4	5	3	3	1	5	20	7,6
Allium sativum L.	Garlic	1	2,5	5	5	4	5	5	19,875	7,6
Pisum sativum L.	Pea	1	2,5	5	4	5	5	5	19,625	7,5
Cucurbita pepo L. *subsp. pepo.*	Zucchini	5	4	5	3	2	1	5	19,5	7,4
Lactuca sativa L.	Lettuce	2,5	4	5	5	3	1	5	19	7,2
Cucumis sativus L.	Cucumber	4	4	5	3	3	1	5	19	7,2
Daucus carota L.	Carrot	2,5	2,5	5	4	3	3	5	18,625	7,1
Cynara scolymus L.	Artichoke	4	5	5	2	3	3	3	18,5	7,0
Phaseolus vulgaris L.	Green beans	1	4	5	3	5	3	5	18,5	7,0
Manihot esculenta Crantz	Casava	5	5	5	1	3	5	1	18,25	7,0
Cichorium endivia L.	Endive	4	4	5	2	3	1	5	18,25	7,0
Ananas comosus (L.) Merr.	Pineapple	5	4	5	3	4	3	1	18	6,9
Allium porrum L.	Leek	2,5	2,5	5	3	3	3	5	17,875	6,8

Apium graveolens L. *var. dulce* Pers.	Celery	4	4	5	1	3	1	5	17,5	6,7
Cynara cardunculus L.	Thistle	1	4	5	1	3	5	5	17,5	6,7
Dioscorea cayennensis subsp. Rotundata (Poir.) J.Miège	Yam	5	4	5	1	3	5	1	17,5	6,7
Raphanus sativus L.	Radish	1	4	5	1	3	5	5	17,5	6,7
Brassica oleracea L. *var. italica*	Broccoli	2,5	2,5	5	2	3	3	5	17,125	6,5
Brassica oleracea var. botrytis L.	Cauliflower	2,5	2,5	5	2	3	3	5	17,125	6,5
Brassica napus L.	Turnip	1	2,5	5	2	3	5	5	17,125	6,5
Beta vulgaris L. *var. cicla.* L.	Chard	2,5	5	5	1	3	1	5	16,75	6,4
Spinacia oleracea L.	Spinach	0	2,5	5	4	3	1	5	14,625	5,6

4.2. Choice of type of irrigation

The analysis for choosing the type of irrigation to be used in the farm has been done for four types of irrigation: drip irrigation, micro sprinkler irrigation, flood irrigation, hand irrigation with hose. Different criteria have been taken into account such as facility to obtain parts, investment, cost of maintenance, environmental impact and erosion.
Irrigation by sprinkling, runoff, pivot due to the impact they have on the environment and the soil have been ruled out from the beginning, and on the other hand to the type of crop, since it is better not to wet the leaves of the majority To prevent disease spread.

The conclusion is that the irrigation that best adapts to the objectives of the project is the drip irrigation compensated, using connectors of four exits with their respective micro tubes and stakes for each plant. In this way, costs are saved by reducing the number of drippers and portagoteros branches.

4.3. Choice of handling

4.3.1. Choice of Rotation

A series of norms are established with which an adequate rotation is ensured according to the nutritional needs of the plants, their effect on the soil and the complementarity between species.

With this, and with the ranking of species, the responsible for the exploitation must choose between the species proposed according to the needs of the moment, whether environmental or socioeconomic, with the highest possible precision.

4.3.2. Obtaining inputs

The difficulty of accessing markets, especially to agricultural markets, obliges to use the local means to supply inputs to the farm. The main inputs, which are referred to in this project are organic matter and nitrogen fertilizer.

Organic matter can be added to soil in many ways, from manure to fresh plant remains. In this case, 15 ha of the 30 ha of the farm have been reserved exclusively for organic matter, mostly in the form of leaves of acacia and herbaceous monocotyledonous plants. They will be obtained in two states, dry and green. The former has a high C / N ratio, thus slowing the release of nitrogen. In contrast, green leaves, with higher protein content, have a lower C / N ratio, thus accelerating the release of nitrogen in the soil solution.

In any case, it will always be possible to invite farmers in the area to graze on that part of the farm to improve the quality of organic matter.

4.3.3. Choice of site

The property will be equipped with drip irrigation that will be driven by a water pump. Therefore, it is essential that the operation is as close to the river as possible so that the load losses up to the end of the hydraulic circuit are minimal, thus saving costs. On the other hand, the forest masses of riverside, and those with a high environmental value, have been respected. With all this has been chosen to establish the exploitation as shown in the following image:

Image 5: Location of the horticultural exploitation. (Source: Google Earth and MeasureMap)

4.3.4. Weed control

Napier grass (Pennisetum purpureum Shumach.) Is undoubtedly the plant species that most interferes with agricultural activity. With the arrival of the first rains this annual monocotyledonous plant springs suddenly and in the short space of a month it reaches several meters high. In addition you can find this plant throughout the region, even reaches a point where you can only see this plant because of its great height.

Apart from the Napier grass there are innumerable plant species that can interfere with the crops, although to a much smaller extent than the previous one. Therefore, different weed control methods have been analyzed taking into account the availability of resources, the cost of investment and maintenance, environmental impact and effectiveness. The methods analyzed are chemical fighting, the use of anti-weed meshes, and manual wrestling with hand tools.

It has been concluded that the best way to combat weeds is manually. The chemical struggle poses an environmental danger that is too high for an area of great diversity and biological interest such as African savannas. On the other hand, anti-weed meshes and the hiring of workers for the manual struggle are the same cost, therefore priority is given to the hiring of labor since it is a cooperation project.

4.3.5. Pests and diseases prevention and control

For the prevention and control of pests and diseases, FAO's recommendations for diversified vegetable cultivation, crop rotation and maintenance of nearby forests have been followed to maintain a balanced population of insects, fungi, bacteria and virus, Which remains below economically harmful levels.

On the other hand, the Ethiopian state has mechanisms to fight against pests and diseases that it initiates when necessary. The last fight that took place in Gambella was against the corn stalk borer and the state fumigated for all the exploitations of the region.

Pesticides are distributed by the BAG (Bureau of Agriculture of Gambella) but their procurement can be extended for too long and special authorization is required.

5. PROJECT ENGINEERING

5.1. Process Engineering

5.1.1. Production program

Since it is a didactic orchard, in which the students of the agricultural course will practice their practices, the crop calendar has been adapted to the Ethiopian school calendar, which runs from September to July. In this way, the students will be able to contemplate all the stages of the crop, their phenological states, and the management from beginning to end.

To facilitate management, two durations of crop cycles, long (more than 4 months) and short (less than 4 months) have been established. The courses last 4 months and start in September, January and May, so the planting will take place in those months. If a short-cycle crop is planted, it will last for the duration of the course, if a long-cycle crop is sown, it is established that it lasts two or three school years.

In order to know the potential average yields for which exploitation can be obtained, data from FAOStat have been obtained from average yields of different representative crops in Ethiopia and South Sudan, since, although the means of production and infrastructure correspond to the Of Ethiopia, the agro-climatic zone corresponds to that of South Sudan, so that the production will be comprised between one and the other.
As a general term, three crops are produced per year of short cycle (less than four months), or two long cycle (more than four months).

Table 5: Average yields in kg / ha.year of some vegetables in Ethiopia and South Sudan. (Source: FAO Stat)

Cultivation / Country	Etiopía	Sudán del Sur
Garlic	10468	4545
Eggplant	SD	19060
Nice	28463	SD
Peanut with peel	1380	552
Pumpkin and Chayote	SD	16666
Casava	SD	1538
Dried onion	10024	19047
Fresh Onion and Shallots	12142	SD
Cauliflower and Broccoli	SD	20000
Beans	1262	3571
Fresh Beans	4133	4687
Chickpea	1710	SD
Ginger	2857	SD
Fresh Vegetables in general	3111	6666
Lettuce and chicory	12500	SD
Fresh vegetables	1568	848
Melons	SD	23000
Okra	SD	11955
Cucumbers and pickles	21428	11904
Fresh Peppers and Chilies	2733	7771
Dried peppers and chilies	285	2000
Pineapple	36363	3750
Leeks and other alliaceous vegetables	5818	SD
Roots and Tubers	7272	SD
Cabbage and other Brasicaceas	10418	6578
Watermelon	SD	19047
Taro	SD	2529
Tomato	7670	14287
Yam	27038	SD
Carrots and Turnips	4505	10119

5.1.2. Productive process

Establishment

The high environmental value of these forests, the African savannas, not only for the region but for the rest of the planet, makes it essential for the establishment of the orchard to respect elements with a high environmental value. These elements are the large trees, the tree legumes and the riverside trees that must be identified as the forest is cleared, because under the current conditions most of the farm can not be accessed, and from May with The arrival of the first rains, to any part of the farm due to the sudden outbreak of weeds that reach more than two meters high. This is also achieved by maintaining a healthy soil, obtaining organic matter and shading certain crops that do not tolerate prolonged exposures.

The remaining trees and shrubs should be felled and moved off the farm. They will be in charge of the services of a company for those trees that are dangerous of logging by its location, form or size. The rest and the bushes will be cut by hand with tools and a vehicle to start the stumps.

The cleaning will also be done by hand, with the help of a tractor and a moldboard to collect the deep elements. For these two tasks, manual cutting and clearing will contract unskilled labor, giving priority to the inhabitants of the area of the farm.

Thanks to the moldboard pass, it is also possible to eliminate the weeds present in the ground and to bury most of its seeds. This reduces the incidence of weeds on the crop and starts the operation from a more favorable point in terms of weed control.

The horses will be made by hand, using cables and stakes to draw the lines and once done will proceed to the installation of the irrigation system.

Soil preparation

At each end of the crop cycle, the soil must be prepared for the next crop. Pre-sowing works are common to all crops taking into account that no specific machinery is available. These tasks are:

-In the first place, you must incorporate the amount and type of organic matter established, buried in the soil. This can be done either by hand, or with a disk plow pass, in which case they should be uninstalled and then reinstalled the portagoteros branches.

-Afterwards the rums are formed again and the structures are installed where they are going to plant climbing plants. Taking into account that two hectares are contracted for each hectare of exploitation, the pre-planting time is two weeks.

Cultivation management

Crop management may vary depending on the species and must be adjusted by the operator in each cycle, although there are a number of operations common to all species.

During the rainy season, from early May to late October, and even during the dry season, if the soil is wet for any reason, the emergence of weeds is responsible for most of the decline in productivity. It has been observed in the exploitations of the zone, that once a week the workers eliminate a great amount of weeds. Therefore, the hiring of labor for this work is imperative.

Among the species to be cultivated, there are some that need a pruning to grow vigorously like peppers and / or a tutoring structure to climb such as tomatoes. The construction of the structures will be carried out by the students of the welding course that is taught in the school itself, so that the school as a whole manages to be as efficient as possible by using all the resources available for the development of this project.

Organic matter should be added during the pre-planting and before flowering, which is achieved by providing nutrients in the key phenological stages. If possible, organic matter in the form of dry leaves should be incorporated into the soil before sowing, and organic matter in the form of green leaves before flowering, since as stated above the C / N ratio of the first Is greater than the second, achieving in the first case to decrease the rate of nitrogen release, preserving it for later phenological stages, and in the second case release necessary nitrogen in large quantity during flowering and fruiting.

Irrigation, whose timing can be seen later in water needs, will be handled by the foreman or, if appropriate, by his delegate, and the collection will be done according to his criteria, depending on whether or not it is a staggered crop, conservation Food, and transportation to the school where it will be stored.

Needs

Workforce:

The workforce will be a centerpiece and one of the main expenses. There will be minimal use of machinery for several reasons: it is difficult to find drivers, mechanics and spare parts so that most of the time the tractor is damaged, the nature of the ground prevents optimal use of the tractor, the focus of this Project is that of cooperation and the hiring of labor is one of the social improvements that are given in the area. On the other hand the parish to which the school is attached has several tractors and a driver that will suffice for this project. Therefore, the labor needs are two unskilled workers per hectare for the cultivation work, a foreman to direct the operations, which in this case is the teacher of practices of the school, guards who will protect the Crops of opportunistic animals and a tractor driver.

Table 6: Labor requirements. (Own elaboration)

Type / Year	1	2	3 and next
Not specialized	10	20	30
Tractor driver	1	1	1
Guards	1	2	3
Foreman / Teacher	1	1	1

Organic matter:

The amount of organic matter needed to maintain an adequate level in the soil has been calculated taking into account their nature, leaves of acacia and herbaceous plants mostly monocotyledonous, dry and fresh for an average depth of 30 cm. The coefficients used and the percentages of dry matter for each type of fertilizer are:

S = Area in m2 = 10000
P = Depth in m = 0.3
Da = Apparent density in t / m3 = 1,3
% Mssecos = Percentage of dry matter for dry waste = 70
% Msfrescos = Percentage of dry matter for fresh waste = 17,5
K1secos = Isohmical coefficient for dry residues = 0.15
K1frescos = Isohmum coefficient for fresh waste = 0.25
K2 = Coefficient of mineralization for clay loam soils in warm tropical climate = 0.06

In the following table you can see the values of organic matter in the soil before and after the pass of the moldboard that mixes the first 40cm of soil:

Table 7: Soil organic matter before and after the moldboard pass. (Own elaboration)

PROPERTIES / DEPTH (cm)	0-5	5-15.	15-30	30-40
Organic material (%)	7,1	3,3	2,8	1,5
O.M. Diagnosis	Excessive	Rich	Correct	Very poor
Soil volume (m3 / ha)	500	1000	1500	1000
Bulk density (t / m3)	1,3	1,3	1,3	1,3
Soil weight (t/ha)	650	1300	1950	1300
Quantity M.O. (T/ha)	45,838	42,484	53,664	20,124
PROPERTIES / DEPTH (CM)	0-40			
Organic matter (t/ha)	162,11			
Soil volume (m3 / ha)	4000			
Floor weight (t)	5200			
% M.O.	3,11			
O.M. Diagnosis	Rich			

As you can see, it is not necessary to increase the amount of organic matter in the soil because it is at the correct levels. On the other hand, the amount to be added every year to maintain this percentage is 44.57 tons per hectare of dry waste, and 53.48 tons per hectare of fresh waste. Only the rills (50% of useful area) will be paid, so the final amount to be contributed per year is 22.28 t / ha and 26.74 t / ha respectively. It has been

calculated taking into account that 2/3 of the total contribution in the month of April in the form of dry leaves and 1/3 distributed during the year in the form of green leaves, when the crops are developed and the nitrogen needs increase . This gives 250 kilograms of nitrogen per hectare per year. The dry residues are incorporated in April because, due to their high C / N ratio, the soil nitrogen is sequestered to release it throughout the year. The fresh residues must be supplied before flowering because, due to their low C / N ratio, a release of the nitrogen in the soil solution is made available to the plant. However, due to the seasonality of the rains, it is not possible to obtain fresh or dry residues during the whole year, and the school does not have the means to accurately measure the amount incorporated. For this and to simplify the tasks, once a month will proceed to the collection of organic matter in the wooded part of the farm. This large amount of organic matter can not be supplied by the wooded part of the farm, since according to the agricultural productivity index of Turc, can be obtained around 25 tons per hectare per year.

Water:

Due to the great variety of crops to be treated on the farm, and the possibility of obtaining up to three harvests a year, it is necessary to have a versatile irrigation schedule, adapted to the needs of each crop, depending on whether they are Of short or long cycle, and to each date of sowing. This has been done using FAO's CropWat software, which takes into account climatic, soil and crop variables to establish monthly irrigation flows. A series of calendars have been obtained that distinguish the following criteria:

- long cycle crops with high water needs planted in September, January and May.
- long cycle crops with average water needs planted in September, January and May.
-long cycle crops with low water needs seeded in September, January and May.
-short cycle crops with high water needs planted in September, January and May.
-short cycle crops with average water needs planted in September, January and May.
-short cycle crops with low water needs planted in September, January and May.

Table 8: Water needs of short cycle crops. (Source: FAO CropWat)

Necesidades bajas												
Caudal/Mes	**Sep**	**Oct**	**Nov**	**Dic**	**Ene**	**Feb**	**Mar**	**Abr**	**May**	**Jun**	**Jul**	**Ago**
mm/día	0	0,4	1,6	0,9	0,9	1,9	2,4	0,9	0	0	0	0
mm/década	0	3,6	16,2	9,3	9,5	17,3	24,7	9,4	0	0	0	0
mm/mes	0	10,9	48,5	28,0	28,6	51,9	74,0	28,2	0	0	0	0
L/ha.s	0	0,0	0,2	0,1	0,1	0,2	0,3	0,1	0	0	0	0

Necesidades medias												
Caudal/Mes	**Sep**	**Oct**	**Nov**	**Dic**	**Ene**	**Feb**	**Mar**	**Abr**	**May**	**Jun**	**Jul**	**Ago**
mm/día	0	0,5	1,7	1,1	1,2	2,1	2,5	1,2	0	0	0	0
mm/década	0	4,7	17,3	11,3	12,1	19,2	26,0	11,7	0	0	0	0
mm/mes	0	14,0	51,9	33,9	36,4	57,5	78,1	35,2	0	0	0	0
L/ha.s	0	0,1	0,2	0,1	0,1	0,2	0,3	0,1	0	0	0	0

Necesidades altas												
Caudal/Mes	**Sep**	**Oct**	**Nov**	**Dic**	**Ene**	**Feb**	**Mar**	**Abr**	**May**	**Jun**	**Jul**	**Ago**
mm/día	0	0,6	1,8	1,3	1,4	2,3	2,7	1,4	0	0	0	0
mm/década	0	5,7	18,4	13,6	14,7	21,0	27,4	14,5	0	0	0	0
mm/mes	0	17,1	55,3	40,7	44,2	63,1	82,2	43,5	0	0	0	0
L/ha.s	0	0,1	0,2	0,2	0,2	0,3	0,3	0,2	0	0	0	0

Table 9: Legend Table 4: Water needs of short cycle crops. (Own elaboration)

	Sembrado el 1 de septiembre y cosechado hasta el 20 de diciembre
	Sembrado el 1 de enero y cosechado hasta el 20 de abril
	Sembrado el 1 de mayo y cosechado hasta el 20 de agosto

Table 10: Water needs of long cycle crops. (Source: FAO CropWat)

Necesidades bajas

Caudal/Mes	Ago	Sep	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago
mm/día	0,0	0,0	0,0	1,1	2,2	0,9	1,1	1,7	1,9	0,0	0,0	0,0	0,0
		0,2	0,1			2,5	0,7			0,5	0,0		
mm/década	0,0	0,0	0,4	10,7	23,1	9,5	10,6	17,1	19,2	0,0	0,0	0,0	0,0
		1,7	0,6			26,3	6,2			5,2	0,0		
mm/mes	0,0	0,0	1,1	32,2	69,4	28,6	31,9	51,2	57,6	0,0	0,0	0,0	0,0
		5,1	1,7			79,0	18,6			15,5	0,0		
L/ha.s	0,0	0,0	0,0	0,1	0,3	0,1	0,1	0,2	0,2	0,0	0,0	0,0	0,0
		0,0	0,0			0,3	0,1			0,1	0,0		

Necesidades medias

Caudal/Mes	Ago	Sep	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago
mm/día	0,0	0,0	0,1	1,2	2,4	1,2	1,4	1,8	2,1	0,0	0,0	0,0	0,0
		0,2	0,1			2,7	0,9			0,6	0,0		
mm/década	0,0	0,0	1,1	12,3	24,4	12,1	13,0	19,0	20,6	0,0	0,0	0,0	0,0
		2,4	1,0			27,7	8,2			6,4	0,0		
mm/mes	0,0	0,0	3,3	36,9	73,1	36,4	39,1	57,1	61,8	0,0	0,0	0,0	0,0
		7,3	3,1			83,2	24,6			19,1	0,0		
L/ha.s	0,0	0,0	0,0	0,1	0,3	0,1	0,2	0,2	0,2	0,0	0,0	0,0	0,0
		0,0	0,0			0,3	0,1			0,1	0,0		

Necesidades altas

Caudal/Mes	Ago	Sep	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago
mm/día	0,0	0,0	0,2	1,4	2,5	1,4	1,7	2,0	2,2	0,0	0,0	0,0	0,0
		0,3	0,3			2,8	1,1			0,7	0,1		
mm/década	0,0	0,0	1,8	13,9	25,6	14,7	15,4	21,0	22,0	0,0	0,0	0,0	0,0
		3,5	2,9			29,1	10,4			7,6	0,9		
mm/mes	0,0	0,0	5,4	41,6	76,7	44,1	46,2	63,0	65,9	0,0	0,0	0,0	0,0
		10,4	8,6			87,3	31,3			22,7	2,6		
L/ha.s	0,0	0,0	0,0	0,2	0,3	0,2	0,2	0,2	0,3	0,0	0,0	0,0	0,0
		0,0	0,0			0,3	0,1			0,1	0,0		

Table 11: Legend Table 6: Water needs of long cycle crops. (Own elaboration)

	Sembrado el 1 de septiembre y cosechado entre mediados y finales de febrero
	Sembrado el 1 de enero y cosechado entre mediados y finales de junio
	Sembrado el 1 de mayo y cosechado entre mediados y finales de octubre

5.2. Engineering Design

For the design of the farm, the local custom and the average size of the plots exploited by the inhabitants of Gambella have been taken into account, in addition to irrigation and proximity to the river. These are small, of between half a hectare and two hectares and are exploited by only one member of the family, sometimes with the help of cattle. This way you have:

-The farm will be formed by the horticultural exploitation and the wooded area.

-The farm has three plots, the first will be installed in year 0, the second in year 1 and the third in year 2

- The plots contain 10 subplots arranged in two rows separated by a central path, of 5 subplots grouped by the width.

-The subplots are the smallest unit and its measures are 50 m wide by 100 m long (0.5 hectares), imitating local farms. In it the horses will be installed.

-The ridges will have dimensions of 80 cm wide by 100 m long and 15 cm high. The corridors between terraces will have a width of 80 cm. In this way, each subplot will have 31 horses, and a useful area of 50%.

It has also taken into account the possibility of introducing tractors and vehicles on the farm for which a central road is planned that crosses the farm wide enough, six meters, to fit an average tractor and people on both sides of the road. The 30 half hectare plots, 50 m long per 100 m long, will be located forming a row of subplots on each side of the central path. This will ensure that you do not have to travel more than 100 meters to unload the products in the vehicle. A series of plans of the property is provided showing the layout of plots and subplots.

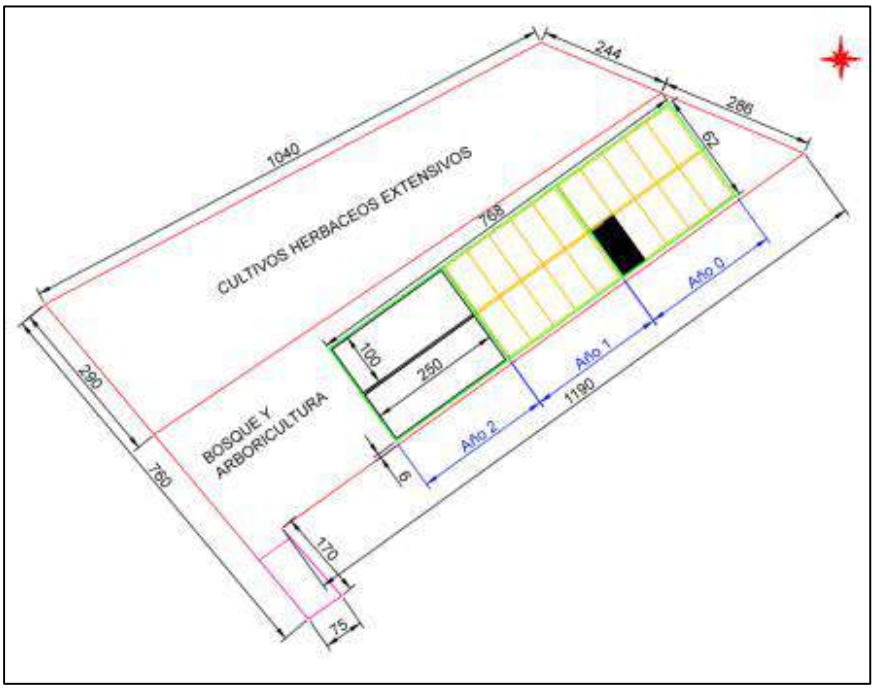


Figure 6: Arrangement of plots and subplots in the farm. (Own elaboration)

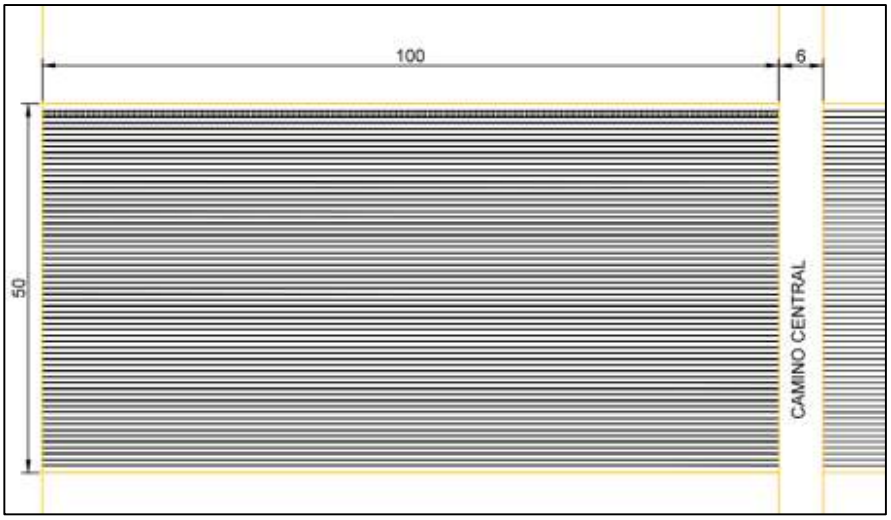


Figure 7: Layout and size of the subplots. (Own elaboration)

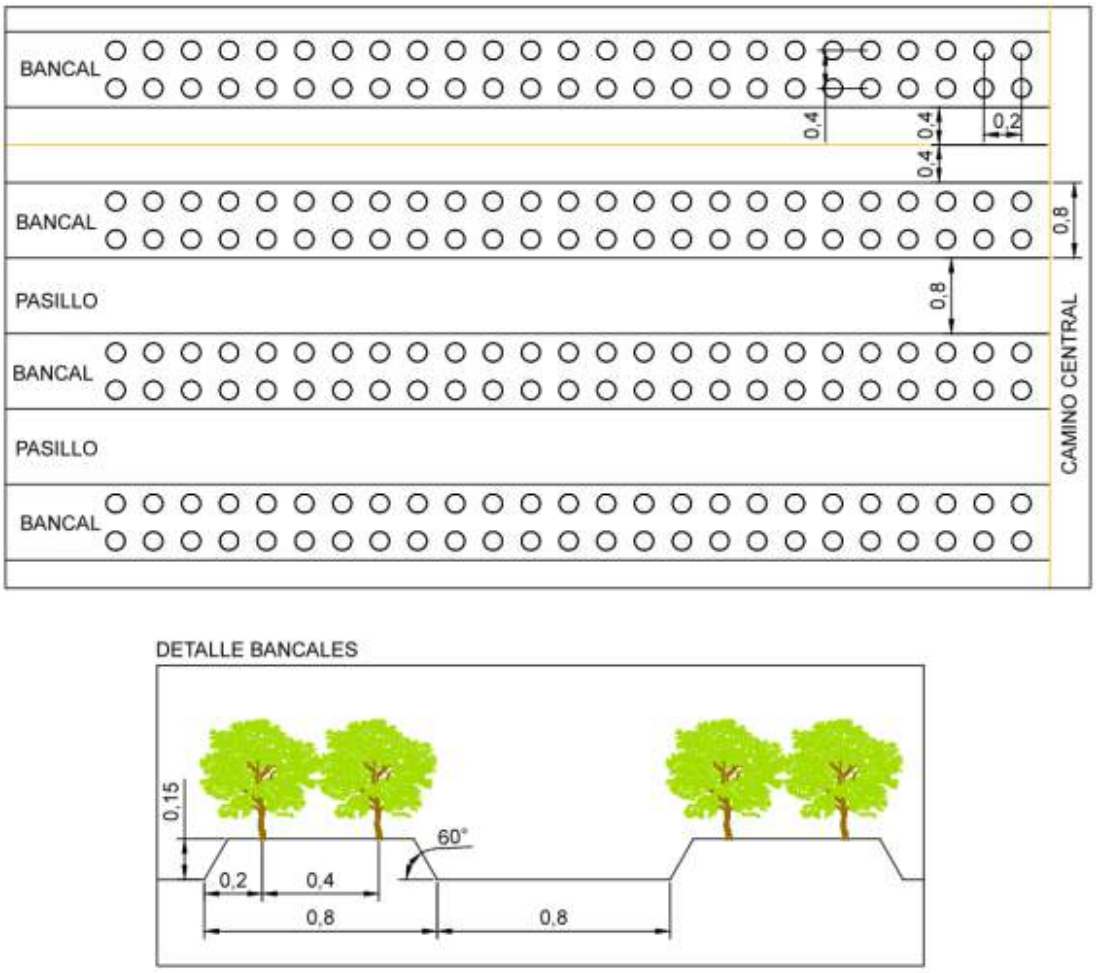


Figure 8: Detail of ridge and corridors between ridge. (Own elaboration)

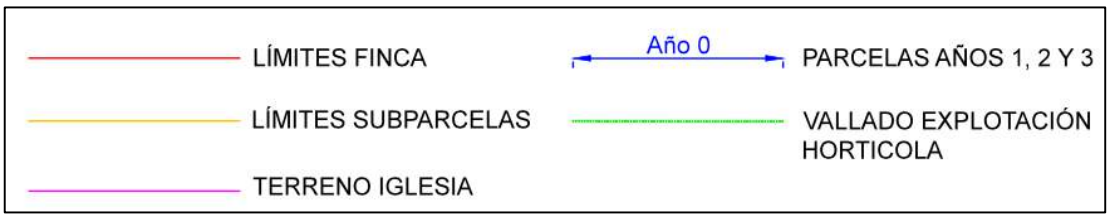


Figure 9: Legend figures 3, 4 and 5. (Own elaboration)

5.3. Engineering of works and installations

Works: Wateringhouse

To boost the irrigation system it is necessary to use a motor pump. For greater security and to facilitate the handling, this must be housed in a house of irrigation.

Its manufacture will be commissioned by masons of the region. It will have a concrete floor HN-25 with a mesh of 15 cm by 15 cm and bars of 6 mm in diameter, and will have dimensions of 3 m wide by 3 m long and a height of 2.4 m. The walls will be made of concrete brick that are 10 cm wide and are thick enough to prevent theft, as the motor pump, filters, petrol cans and some tools will be housed inside. A slope will be made to prevent the rise of the water of the floor by capillarity and will install a roof of corrugated

sheet. Finally, the house will have two windows of half a meter high by one meter wide with metal grille, two openings in the bottom 25 cm by 25 cm to improve ventilation, a gas outlet where the exhaust pipe The motor pump, and two openings for suction and secondary piping.

Facilities: Irrigation system

The hydraulic calculations have been made by the energy expenditure, that is to say the load requests in the circuit, the necessary pressure height in the drippers and the pressure provided by the motor pump. They have chosen a motor pump that will provide 15500 L / h at a pressure height of 30 meters of water column. This is achieved thanks to the number of drippers that will remain open at the same time, 7750 drippers, and the fact that they are compensated drippers with a flow rate of 2 L / h.

The suction piping will run from the river to the irrigation hut, the secondary pipeline will run a maximum of 200 m across the farm width from the hut, and the two primary pipelines will go on both sides of the central path along the farm. All of them will be buried 60 cm deep. In each subplot a deviation will be made from the primary pipe, and on the surface, it will be connected to the pipe portaramales. The branches will be connected to the latter and there will be one for each ridge, that is 31 per subplot with a branch spacing of 1.6 m. The droppers will have a separation of 40 cm, that is to say 250 drippers per horse, each dropper with four exits.

6. PLANS

Seven plans have been prepared that synthesize project information and serve as a basis for project execution. The plans provided are:

- Plan 1: Project location
-Plan 2: Location of school and farm
- Plan 3: Layout of plots
- Plan 4: Irrigation
- Plan 5: Detail of the irrigation system 1
-Plan 6: Detail of the irrigation system 2
- Plan 7: Wateringhouse

7. SCHEDULE OF IMPLEMENTATION

The activities scheduled for the establishment of horticultural exploitation extend from April 2016 to the beginning of the first crop cycle in May 2018. In the following schedule you can see the planned schedule:

Table 12: Project timeline

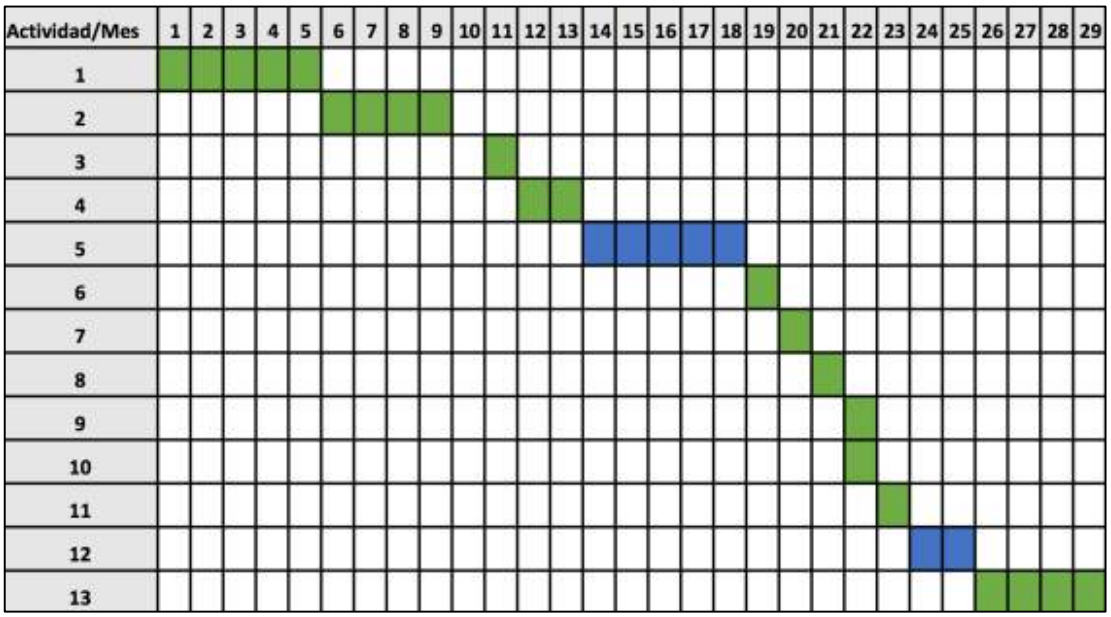
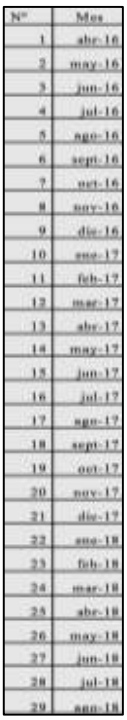


Table 13: List of Activities and Scheduled Months



Nº	Mes
1	abr-16
2	may-16
3	jun-16
4	jul-16
5	ago-16
6	sept-16
7	oct-16
8	nov-16
9	dic-16
10	ene-17
11	feb-17
12	mar-17
13	abr-17
14	may-17
15	jun-17
16	jul-17
17	ago-17
18	sept-17
19	oct-17
20	nov-17
21	dic-17
22	ene-18
23	feb-18
24	mar-18
25	abr-18
26	may-18
27	jun-18
28	jul-18
29	ago-18

Nº	Activity
1	Stay in Gambella: edafo-climatic analysis, market research and others.
2	Work Proposal and Document Preparation
x	Start up of the holding:
3	Study and choice of trees
4	Tree felling
5	Rainy season interruption
6	Clearing and perimeter delimitation of the estate and paths with stones
7	Minimum leveling
8	Banking Elaboration
9	Installation of the irrigation system
10	Irrigation house construction
11	Fence
12	Two month margin
13	First cycle of cultivation

8. BUDGET

The budget has been divided into 5 chapters and a section on import costs, and the table of measurements, price table (1), detailed price table (2) showing the costs of each material And labor, and the partial budget for each. Labor has been calculated taking into account that the average wage is 3,000 Birr per month. In the following table you can see the total by chapters, whose sum corresponds with the budget of material execution:

Table 14: Budget by chapters. (Own elaboration)

PRESUPUESTO TOTAL POR CAPÍTULOS			
Chapter 1:	TREE CUT AND SCREWED	4.995,00 €	119.880,00Br
Chapter 2:	EARTH MOVEMENTS	145,60 €	3.494,40Br
Chapter 3:	PIPELINES	165.775,54 €	3.978.612,96Br
Chapter 4:	IRRIGATION HOUSE	5.000,00 €	120.000,00Br
Chapter 5:	WATER PUMP	550,00 €	13.200,00Br
IMPORT	CONTEINER 40 FEET	1.600,00 €	38.400,00Br
	SHIPPING	1.600,00 €	38.400,00Br
	CUSTOMS ETHIOPIA	2.960,00 €	71.040,00Br

The budget of material execution, sum of the 5 chapters and the import section, amounts to the amount of ONE HUNDRED AND EIGHTY-TWO THOUSAND SIX HUNDRED AND TWENTY-SIX EUROS WITH FOURTEEN CENTS. (€ 182,626.14).

The 13% of general expenses amounts to the amount of TWENTY-THREE THOUSAND SEVEN HUNDRED AND FORTY-ONE EUROS WITH FORTY CENTS (€ 23,741.40).

The 0% industrial profit amounts to the amount ZERO EUROS (€ 0)

The 15% VAT amounts to the amount THIRTY THOUSAND NINE HUNDRED FIFTY-FIVE EUROS WITH THERTEEN CENTS (30.955,13 €).

The general budget amounts to TWO HUNDRED THIRTY-SEVEN THOUSAND THREE HUNDRED AND TWENTY-TWO EUROS WITH SIXTY-SEVEN CENTS (€ 237,322.67).

9. ECONOMIC EVALUATION OF THE PROJECT

According to the estimated budget, the investment amounts to € 237,322.67 paid during the first three years and without borrowing.

The useful life of the project has been estimated in 20 years that is determined by the useful life of the irrigation system.

The payments and charges from which the economic profitability will be calculated are the following:

- Ordinary payments are € 19,833 in year 0, € 35,583 in year 1 and € 51,333 from year 2 until the end of the useful life.
These payments correspond to labor, energy consumption and others.

-Extraordinary payments are € 125 in years 4, 9, 14 and 19 which correspond to the renovation of hand tools. In years 7 and 15 they amount to 550 € and corresponds to the renovation of the motor pump that has a useful life of 7 years.

- Ordinary charges are € 0 in year 0, € 30,625 in year 1, € 61,250 in year 2 and € 91,875 in year 3 and corresponds to the sale of crops for an average production of 21 tonnes per hectare per year at an average price of 7Birr (€ 0.29 / kg).

-There are no extraordinary charges over the life of the project

Thus, cash flows are -103,940.88 euros in year 0, -81,565.88 euros in year 1, -66,690.88 euros in year 2, of 40,541.67 euros in the year Years 4, 9, 14 and 19, from € 39,991.67 in the years 7 and 15, and from 40,416.67 in the remaining years.
With the above data and assuming an interest rate of 3% you get:

Table 15: Financial evaluation of the project. (Own elaboration)

Criterion	Value
Net Present Value	278427,75
Investment Benefit Ratio	1,21
Internal Rate of Return	12%
Recovery time	año 9,2

10. ENVIRONMENTAL IMPACT STUDY

The study of environmental impact is essential in this type of project since it is a completely virgin plot and also in an area with a high environmental value since in the area can be found up to 12 species of birds included in the red list Of animals in danger of extinction. We want to counteract the damaging example of the big multinationals that have completely eliminated all traces of diversity on the immensely large farms they exploit. It has been verified that this is so, and in addition the requests of the inhabitants of the area of the farm have been received in person so that not all the trees are felled and the diversity of their forests is conserved from which they obtain basic inputs Such as construction wood and fuel. To this end, an inventory of the different project actions and factors has been made, to analyze the impact of the project on the environment and take the appropriate measures in an objective and justified way. The impact on soil, water, air, fauna, flora, and the local population has been analyzed. The details of the calculations are found in document 5. Environmental Impact Study. In the following tables you can see the measures taken to mitigate the negative effects of the project on the environment:

Table 16: Measures applied on geological and soil impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Wind erosion of the soil
Definition of the measure	Permanent plant cover
Objective	Avoid the movement of soil material due to the action of the wind.
Effectiveness	High
Description of the measure	Establishment and management of a permanent vegetal cover in the streets of the exploitation and placement of stones between the subplots.
Entity responsible for its management	Owner or manager of the operation.
Moment in which it is included	From the first year

Table 17: Measures applied on fauna impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Fauna (Birds)
Definition of the measure	Creation of artificial nests
Objective	Increase bird's eye appeal
Effectiveness	Half
Description of the measure	Special attention should be given to natural nests, protecting them at all costs, as well as to the habitat of the nest. In addition, artificial nests will be created to increase the attractiveness of the farm in the eyes of the birds.
Entity responsible for its management	Owner or manager of the operation and local population.
Moment in which it is included	From the first year

Table 18: Measures applied on flora impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Loss of vegetation and tree diversity
Definition of the measure	Planting trees of various species
Objective	Increase the conservation value of the farm in its entirety.
Effectiveness	Very high
Description of the measure	Plantation of diverse species of trees of high conservation value, in the edges of the farm and of the roads for vehicles, and in the forest of the plot, to increase its density and tree diversity.
Entity responsible for its management	Owner or manager of the operation.
Moment in which it is included	From the first year

Table 19: Measures applied on landscape impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Visual Incidence
Definition of the measure	Creating a natural visual display
Objective	Decrease visual intrusion
Effectiveness	High
Description of the measure	Maintenance of an adequate density of trees planted at the edges of the farm, orchard and roads to avoid visual intrusion, especially in areas with greater visual incidence.
Entity responsible for its management	Owner or manager of the operation.
Moment in which it is included	From the first year

Table 20: Measures applied on socio-economic environment impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Social acceptance
Definition of the measure	Labor recruitment and educational offer
Objective	Maintain good social acceptance of the project
Effectiveness	Very high
Description of the measure	Priority for the local population in the hiring of personnel. Inclusion in agricultural courses. Promotion of good agricultural practices and diversification of sources of income.
Entity responsible for its management	Owner or manager of the operation and local inhabitants.
Moment in which it is included	From the first phase of the project

Table 21: Measures applied on hydrological impact. (Own elaboration)

Medidas protectoras	
Impact to which it is directed	Water use
Definition of the measure	Efficiency in water use
Objective	To be as efficient as possible in the use of water and to reduce the impact on the Baro River
Effectiveness	Half
Description of the measure	Use of precise irrigation systems, paying special attention to their management to not irrigate when it is not necessary
Entity responsible for its management	Owner or manager of the operation
Moment in which it is included	From the first phase of the project

11. OF SUSTAINABLE DEVELOPMENT AND DEVELOPMENT COOPERATION

Being a cooperation project, the objectives are focused on improving the quality of life of the local population. In order to be successful, the project must be approached in that direction from the beginning and mark the objectives and expected results in a way that is coherent with the possibilities of the environment and previous experiences. For this, a summary of the country's situation regarding the human development index, the sustainable development objectives, and development cooperation with Spain has been made. The problems and effects, as well as the objectives of the project focused on the eradication of these problems and the expected results were then marked. In addition, in the logical framework you can see the objectives and results, but also specify the means to check if these results are achieved.

The cooperation objectives of this project can be summarized in:

-Improvement of agricultural production, in terms of quantity, quality and variety
-Improvement of the family economy of the project participants and inhabitants of the area of the farm.
-Improved nutrition, especially for the youngest and women in rural areas.

Madrid, December 2016
Student
Sebastián Sangro Lucas

ANNEX 1: ANALYSIS AND DIAGNOSIS OF THE SITUATION OF DEPARTURE

Sebastián Sangro Lucas

INDEX

1. BACKGROUND AND CONDITIONERS

1.1. LEGAL

- Proclamation for the development and conservation of apiculture resources (Apiculture resources development and protection No. 660/2009)

- Proclamation for seed control (Seed proclamation No. 206/2000)

- Proclamation for the Improvement of the National Seed Industry Agency (Proclamation to amend the National Seed Industry Agency No. 122/1998)

-Proclamation for the conservation, development and use of forests (Proclamation to provide for the conservation, development and utilization of forests No. 94/1994)

-Proclamation to provide access to genetic resources, and access to information on community rights and knowledge (Proclamation to provide access to genetic resources and community knowledge and community rights No. 482/2006)

-Proclamation on the rights of genetic improvers (Plant breeders' right proclamation No. 481/2006)

-Proclamation on labor rights (Labor Proclamation No. 377/2003)

1.2. IMPLANTATION IN GAMBELLA

Local populations are nomadic-pastoral tradition for thousands of years, migrating from area to area depending on the rainy season or dry season. But in recent decades they have been forced to settle and reduce the number of heads of their flocks due to the massive sale of land to different multinationals. Government and NGO support has focused on helping South Sudanese refugees fleeing war and alleviating the most basic needs of the population. However, there was no real help for the transition from an economic system based on extensive and nomadic livestock to a more diverse and complex agrarian system. Now the vast majority of the population practices subsistence farming, with very low yields and little diversification. Today, there are no local hoe products in the shops of the large towns or villages of Gambella, all of which come from other regions of Ethiopia. The little local production is sold in makeshift sidewalk markets along with what they have managed to fish, collect and rarely hunt.

Therefore, in Gambella there are 4 types of holdings that are defined below:
The large estates exploited by multinationals, ranging from 10,000 ha to 100,000 ha where corn, rice, sesame, cotton, palm, mango, sugar cane and other cashcrops can be found. Nothing produced in these lands is intended for local markets. The whole is sold in Addis Ababa, or is exported directly, leaving no benefit to the local population. In these cases companies have a fleet of very large tractors and tools and offer many jobs, but very specialized so they look for them in the capital.
The lands exploited by local tribes, mostly Anuak and Nuer, ranging from a small patio to half a hectare if shared and where it is difficult to find anything other than subsistence

farming based on the cultivation of maize. Without counting the endless farms, these lands are the most numerous and they are located near the towns, sometimes even in the streets of the town.

Image 1: Day laborers on a farm in Gambella. (Author: Alejandro Martínez Igual)

The lands exploited by highlanders, which come from other regions of Ethiopia with more agricultural tradition and whose land can range from half a hectare to two hectares if shared. These are the second most numerous and in them you can find more variety of crops than in the previous one, such as okra, sesame and other crops for sale in the local market in a walking way.

Farms managed by NGOs where different types and uses can be found and are those that practice a more sustainable and realistic agriculture as a first step to develop agriculture in the region, with low inputs and making the most of available resources with the right knowledge. For example, the farm object of this project pretends to be a field of practice for the classes of FP as well as a food source for the students.

The parish of San José in Gambella also has several areas where maize, mangoes and papayas are grown, which is donated in full to the sisters of the charity of Gambella to supply their hospital and distribute among the population. Horticultural products such as carrots, onions, garlic, cabbage and others are also grown in these areas, although horticulture has been abandoned in recent years since the person who carried it has retired and in the region nobody has the knowledge to do what.

Image 2: Women carrying straw. (Author: Alejandro Martinez Igual)

Also present is the Dutch NGO ZOA-International which has a land of 2 ha about 3 km downstream from the project object, where it teaches permaculture and where cereals such as rice and corn are grown, tubers such as yucca or taro, Trees such as banana, papaya and mango or aromatic plants such as rosemary and lemon grass. It is the most diversified exploitation of which we have evidence.

Unfortunately, there are no production data in Gambella since, if it is not subsistence agriculture or humanitarian aid where production is seldom counted, then it is multinational companies who are reluctant to give any kind of information.

1.3. CLIMATE

1.3.1. Location

Climate data from the FAO Climwat for Cropwat database have been obtained and the nearest meteorological station has been selected, this being Gambella, located 12 km from the farm being processed and at 480 mosl. According to the data recorded in the ClimWat database the characteristics of the station are (TABLE):

Table 1: Weather station data (Source: FAO)

COUNTRY	Ethiopia
REGION	Gambella
WOREDA	Gambella
SUBBASIN	Baro-Akobo
BASIN	Nile
UTM X COORDINATES	674028,291
UTM Y COORDINATES	912280,285
SPINDLE	36P
COORDINATES G.M.S.s	08°14'60,0"N
ALTITUDE (msnm)	34°34'48,0"E
DATA SERIES	480
COUNTRY	15 years min

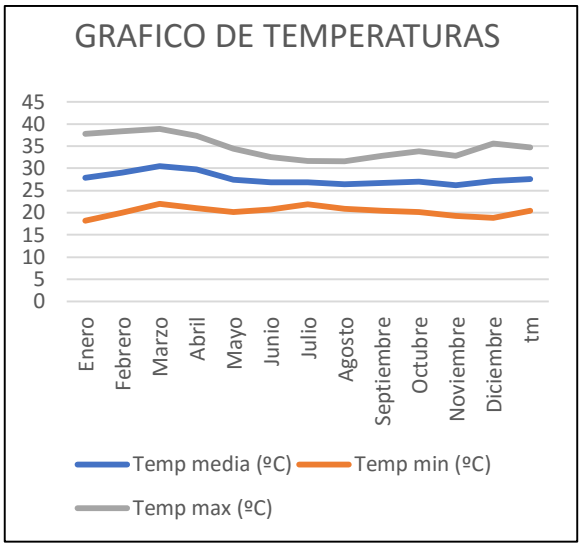
1.3.2. Physical factors

1.3.2.1. *Temperatures*

The data provided by the database comprise the monthly averages and the means of the maximum and minimum temperatures of a dataset of at least 15 years. However, they do not provide information on absolute temperatures or daily data. Below is a chart and a chart showing average temperatures, and maximum and minimum averages throughout the year:

Table 2: Monthly temperatures. (Source: FAO)

Mes	Tempo media	Tempo min	Temp max
	(ºC)	(ºC)	(ºC)
Enero	27,9	18,2	37,8
Febrero	29,1	20,0	38,4
Marzo	30,5	22,0	38,9
Abril	29,7	21,1	37,3
Mayo	27,4	20,2	34,5
Junio	26,8	20,7	32,5
Julio	26,8	21,9	31,7
Agosto	26,4	20,9	31,6
Septiembre	26,7	20,5	32,9
Octubre	27	20,1	33,9
Noviembre	26,2	19,3	32,9
Diciembre	27,1	18,8	35,6
tm	27,6	20,4	34,8



Graphic 1: Monthly temperatures. (Source: FAO)

It can be observed in the first place that there is not much thermal amplitude throughout the year being the maximum of the maximums of 38,9ºC in March and the minimum of the maxims is of 31,6ºC in August, that is to say an amplitude of 7, 3 ° C. In addition, the temperature difference between the minimum and maximum varies slightly throughout the year. The maximum difference is between the months of January and April with an amplitude of 20 ° C and the minimum difference is between May and December with an amplitude of 10 ° C.

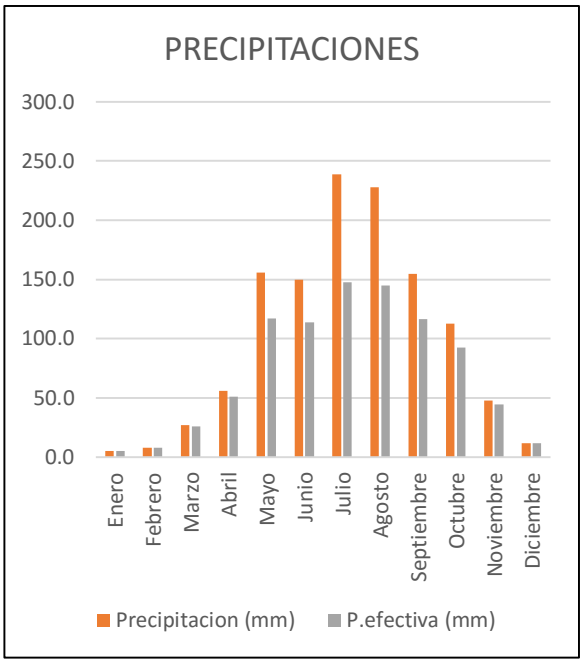
On the other hand, knowing that the frost regime calculated according to L. Emberger and the calculation of the cold hours according to Mota require both minimum average monthly temperatures below 7ºC in order to be applied, it can be said simply by observing the table That there is no risk of frost during the year, nor accumulation of cold hours for the case of fruit trees.

1.3.2.2. *Precipitation*

The following table shows monthly rainfall averages for a data series of 15 years and the actual precipitation calculated by the USDA S.C. method. Method.

Table 3 : Monthly precipitation. (Source: FAO)

Mes	Precipitación (mm)	P. efectiva (mm)
Enero	5,0	5,0
Febrero	8,0	7,9
Marzo	27,0	25,8
Abril	56,0	51,0
Mayo	156,0	117,1
Junio	150,0	114,0
Julio	239,0	147,6
Agosto	228,0	144,8
Septiembre	155,0	116,6
Octubre	113,0	92,6
Noviembre	48,0	44,3
Diciembre	12,0	11,8
Total	1197,0	878,4



Graphic 2 : Monthly precipitation. (Source: FAO)

The effective precipitation is the one that can really be harnessed by the crop. The total precipitation throughout the year is 1197 mm and the effective precipitation is 878.4 mm. As expected for this latitude, in a savanna climate, two periods can be distinguished:

- The dry season where it rains less than 100 mm per month and covers from November to April, with a total precipitation of 156 mm.
- The rainy season where it rains more than 100 mm per month and goes from May to October with a total precipitation of 1041 mm, contributing almost half of the precipitation in the months of July and August with 239 and 228 mm respectively.

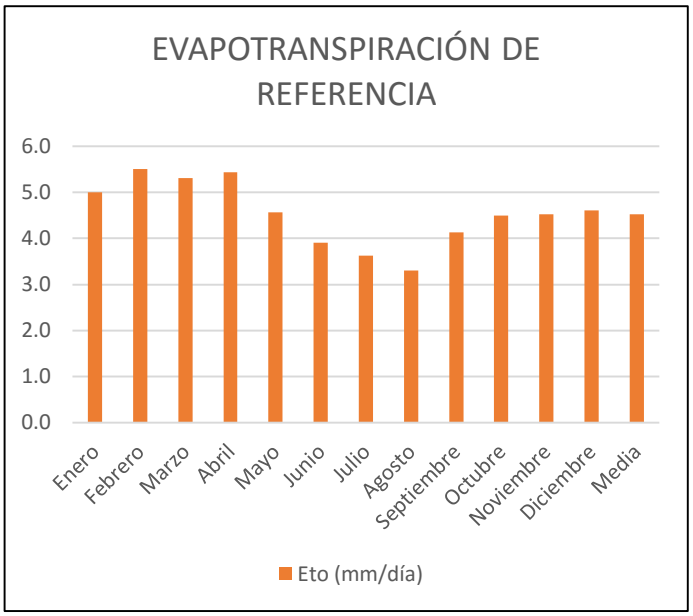
It is important to take into account that in the months of July and August the risk of torrential rains is high so you have to plan the farm well so that at that time the crop is not affected.

1.3.2.3. *Evapotranspiration*

The reference evapotranspiration (ETo) is the loss of soil water in the form of soil evaporation and transpiration of a type vegetation cover for the given area. It has been obtained through the FAO CropWat program using the Penman-Monteith method. This method is widely used by FAO and its calculation takes into account multitude of variables such as climatic factors, humidity, radiation and wind, biological factors, vegetation cover, edaphic factors, soil moisture, texture, and other factors.

Table 4 : Potential evapotranspiration. (Source: FAO)

Mes	Eto (mm/día)
Enero	5,00
Febrero	5,50
Marzo	5,31
Abril	5,43
Mayo	4,57
Junio	3,90
Julio	3,63
Agosto	3,31
Septiembre	4,13
Octubre	4,49
Noviembre	4,52
Diciembre	4,61
Media	4,53



Graphic 3 : Potential evapotranspiration. (Source: FAO)

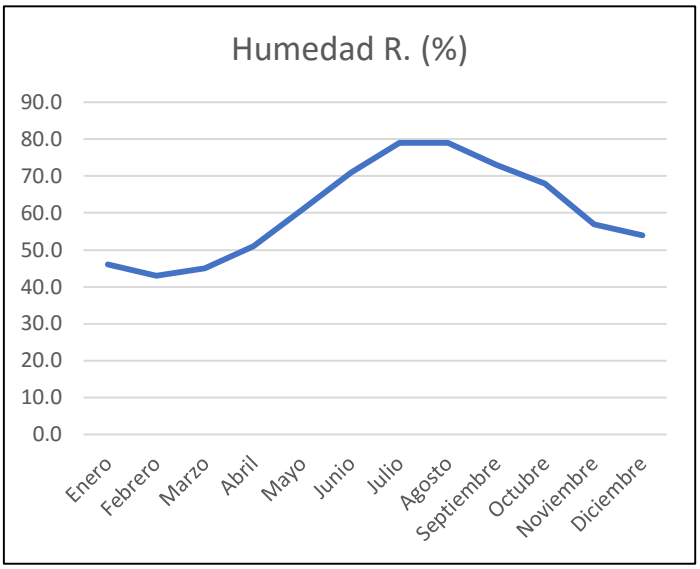
It can be seen that evapotranspiration remains more or less constant throughout the year, with a maximum in February with 5.5 mm and a minimum in August with 3.31 mm. It is possible to suppose that during the rainy season the cloudiness decreases the ETo during the months of May to October.

1.3.2.4. *Relative Humidity*

In the following table (table 5) and graph (graph 4) you can see the monthly averages of relative humidity. Data were obtained from the FAO ClimWat database. This allows us to know the relationship between the amount of water vapor that has an air mass and the maximum it could have.

Table 5: Monthly relative humidity. (Source: FAO)

Mes	Humedad R. (%)
Enero	46,0
Febrero	43,0
Marzo	45,0
Abril	51,0
Mayo	61,0
Junio	71,0
Julio	79,0
Agosto	79,0
Septiembre	73,0
Octubre	68,0
Noviembre	57,0
Diciembre	54,0
Media	61,0



Graphic 4: Monthly relative humidity. (Source: FAO)

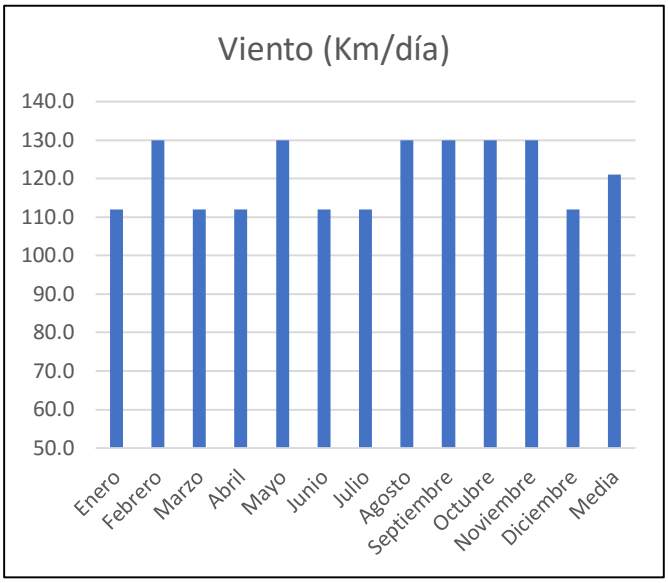
Again we can distinguish two seasons, dry and wet. The dry season runs from May to October with a minimum of 43% RH in February and the wet season with a maximum of 79% RH in July and August. It is necessary to take into account the relative humidity when choosing the handling, especially for crop protection. Having two such marked periods can be foreseen problems typical of the two conditions of relative humidity.

1.3.2.5. *Wind*

In the following chart and graph you can see the monthly averages of wind speeds throughout the year. Data were obtained from ClimWat of FAO. These data give us an idea of the aeration of the plants with which we can adjust the planting frame. In addition, in the case of having trees, together with the temperature data, indicates the risk of mechanical or physiological damages such as branch breakage or asurated respectively.

Table 6 : Average daily wind and speed. (Source: FAO)

Mes	Viento (km/día)	Viento (km/hora)
Enero	112,0	4,67
Febrero	130,0	5,41
Marzo	112,0	4,67
Abril	112,0	4,67
Mayo	130,0	5,41
Junio	112,0	4,67
Julio	112,0	4,67
Agosto	130,0	5,41
Septiembre	130,0	5,41
Octubre	130,0	5,41
Noviembre	130,0	5,41
Diciembre	112,0	4,67
Media	121,0	5,04



Graphic 5 : Average daily wind and speed. (Source: FAO)

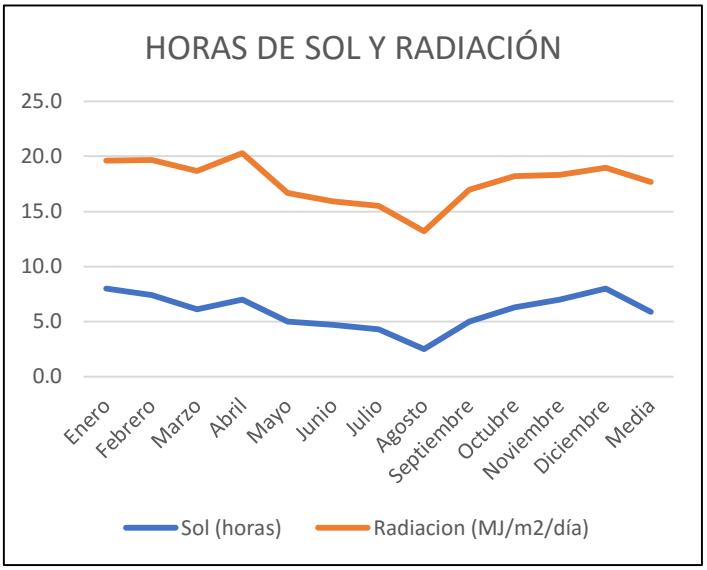
The wind speed is constant throughout the year, with values of 4.67 to 5.41 km / hour. This speed is below 10 km / hour which is at which insects begin to have problems and therefore some pests and diseases, but also pollination is affected.

1.3.2.6. Radiation

Below, the data of average radiation and average hours of sun throughout the year, obtained from the database of ClimWat of FAO are shown.

Table 7 : Hours of sun daily and average daily radiation. (Source: FAO)

Mes	Sol (horas)	Radiación (MJ/m^2.día)
Enero	8,0	19,6
Febrero	7,4	19,7
Marzo	6,1	18,7
Abril	7,0	20,3
Mayo	5,0	16,7
Junio	4,7	15,9
Julio	4,3	15,5
Agosto	2,5	13,2
Septiembre	5,0	17,0
Octubre	6,3	18,2
Noviembre	7,0	18,3
Diciembre	8,0	19,0
Media	5,9	17,7



Graphic 6 : Hours of sun daily and average daily radiation. (Source: FAO)

It can be seen again that during the rainy season the radiation and the hours of sun a day decreases, mainly due to the cloudiness. Even so, the difference between the months with more and less radiation and hours of sun is small since in these latitudes the sun leaves at 6 am and gets at 6 pm all year.

1.3.3. Climate indices and classifications

Next, different indexes are defined that help us to analyze the agricultural potential and the different risks to be taken into account, such as continentality index, Lang aridity index, De Martonne aridity index, aridity index Of UNESCO 1979 and the agricultural productivity index of Turc. In addition, the forest potential index is defined and classified using the

1.3.3.1. Continental Index

Gambella's climate is strongly influenced by rainfall from the tropical rain belt that reaches these latitudes between May and November. Gorczinski's index of continentality gives us an idea of the influence of large bodies of water on the regulation of temperature in the region. In addition, this index takes into account average temperatures and latitude.
Gorczinski Index:

$$Cf = 1{,}7x\left[\frac{tm_{12} - tm_1}{sen\emptyset}\right] - 20{,}4$$

Cf = Gorczinski Index Index
Tm12 = temperature of the warmest month
Tm1 = temperature of the coldest month
Ø = latitude

Table 8 : Areas according to Gorczinski. (Own elaboration)

LEYENDA	ZONA
Cf<10	Marítimo
10<Cf<20	Semimarítimo
20<Cf<30	Continental
Cf>30	Muy continental

$$\mathrm{Cf} = 1{,}7\mathrm{x}\left[\frac{30{,}5 - 26{,}2}{\operatorname{sen} 8{,}25}\right] - 20{,}4 = \mathbf{30,54}$$

The index is above 30 Therefore the project is located in a very continental area according to the Gorczinski index.
The following are the Lang aridity indices, UNESCO aridity indexes of 1979 and the agricultural productivity index of Turc. The Martonne index is not defined because it is more appropriate for cold climates, nor the Emberger index because it is focused on the Mediterranean.

1.3.3.2. Aridity Indices

1.3.3.2.1. Lang aridity index

The Lang index is defined by:

$$\mathrm{Pf} = \mathrm{P}/\mathrm{tm}$$

P = Average annual precipitation in mm
Tm = average annual temperature in ° C
The possible areas are:

Table 9 : Areas according to Lang. (Own elaboration)

Valor de Pf	Zona
0<Pf<20	Desert
20<Pf<40	Arid
40<Pf<60	Humid steppe and savannah
60<Pf<100	Light forest moist
100<Pf<160	Humid forests
Pf>160	Perhumid with meadows and tundras

$$\mathrm{Pf} = \frac{1197}{27{,}63} = 43{,}32$$

The index is 43,32 ; it is Humid steppe and savannah

1.3.3.2.2. De Martonne aridity index

The De Martonne index is defined by:

$$I_a = \frac{\mathrm{P}}{[tm + 10]}$$

And it is divided into the following zones:

Table 10 : Areas according to De Martonne. (Own elaboration)

Valor de I_a	**Zona**
$0<I_a<5$	Desert (Hyperarous)
$5< I_a <10$	Semi-desert (Arid)
$10< I_a <20$	Mediterranean semi-arid
$20< I_a <30$	Subhumid
$30< I_a <60$	Damp
$I_a >60$	Perhumid

Therefore, the area is wet zone.

In addition to the annual index, De Martonne has another index for each month that also serves to calculate the potential forest productivity index. It is given by:

$$I_{ai} = \frac{12 \times P_i}{[tm_i + 10]}$$

Pi = mean monthly precipitation in mm
Tmi = average monthly temperature in ºC

The following table shows the results obtained for each month:

Table 11: De Martonne monthly index. (Own elaboration)

Mes	Ia
Enero	1,6
Febrero	2,5
Marzo	8,0
Abril	16,9
Mayo	50,1
Junio	48,9
Julio	77,9
Agosto	75,2
Septiembre	50,7
Octubre	36,6
Noviembre	15,9
Diciembre	3,9

1.3.3.2.3. UNESCO Dryness Criteria

A. Barrenness:
It is calculated by mean annual precipitation and estimated evapotranspiration by the Penman method in mm.

$$A = \frac{P}{ETP_{Penman}}$$

Table 12: Areas according to UNESCO-FAO. (Own elaboration)

A	Zonas
A<0,03	Hiperárido
0,03<A<0,2	Árido
0,2<A<0,5	Semiárido
0,5<A<0,75	Subhúmedo

$$A = \frac{1197}{1653,295} = 0,72$$

The Aridity Index is 0.72, therefore, it is a sub-humid zone

B. Temperature:
The type of winter and the type of summer are defined according to the temperatures of the coldest month and the warmest month respectively:

Table 13: Types of summers and winters according to UNESCO-FAO. (Own elaboration)

Temperatura media del mes más frío	**Tipo de invierno**
$tm_1<0$	Frío
$0<tm_1<10$	Fresco
$10<tm_1<20$	Templado
$20<tm_1<30$	Cálido

Temperatura media del mes más cálido	**Tipo de verano**
$10<tm_{12}<20$	Templado
$20<tm_{12}<30$	Cálido
$tm_{12}>30$	Muy cálido

In our case tm1 is 26.2ºC and tm12 is 30.5ºC, therefore, the project is in a warm winter area and very warm summer.

C. Number of dry months:
The number of dry months are those in which the average precipitation is less than 30mm:

$$P_i < 30mm$$

In this case, the number of dry months is 4 months, from December to March both inclusive.

D. Period of drought:
The arid zone is characterized according to the season or seasons in which the dry season occurs. The possible areas are:

-Maximum in summer
-Maximum in summer and another period in winter less marked and of shorter duration
-Maximum in winter
-Maximum in winter and another period in summer less marked and of shorter duration
-Maximum in spring and autumn
-Regular records

The period of drought extends from December to March, during the winter months, and there is no other period in summer less marked and of shorter duration, therefore, the zone is of maximum drought in winter.

1.3.3.3. Productivity Index

1.3.3.3.1. Forest Potential Productivity Index

Paterson's potential forest productivity or CPV, of a species compatible with the stability of the environment, is the maximum production that can be obtained in an area with mature and balanced soil, technical management of rope and good phytosanitary status. High temperatures and heavy rainfall are considered essential for high forest mass production. The Paterson CPV index is given by the expression:

$$\text{CPV} = \frac{tm_{12} \times G \times P \times f}{12 \times \lfloor T_{12} - t_1 \rfloor}$$

P = Average annual precipitation in mm
Tm12 = average temperature of the warmest month
T1 = mean temperature of the lowest of the coldest month
T12 = average temperature of the maximum of the warmest month
G = duration of the vegetative period in months
F = sunshine factor

For the calculation of G, considering that it is a warm or tropical zone, vegetation months are considered those in which the monthly De Martonne index is greater than 20 and in addition the average monthly temperature is higher than 10ºC. This period extends from May to October both included, and the average temperatures are always above 10 ° C, therefore, the duration of the vegetative period is 6 months.

The insolation factor is given by

$$\text{f} = \frac{2500}{\lfloor n + 1000 \rfloor}$$

n = number of total hours of insolation per year

$$\text{f} = \frac{2500}{\lfloor 2166{,}25 + 1000 \rfloor} = 0{,}79$$

Paterson's potential forest or PV productivity index is:

$$\text{CPV} = \frac{30{,}5 \times 6 \times 1197 \times 0{,}79}{12 \times \lfloor 38{,}9 - 18{,}2 \rfloor} = 696{,}66$$

The potential production in cubic meters of wood per hectare and year is given by the regression whose expression is:

$$\text{y}(m^3\text{de madera por ha y año}) = (5{,}3 \times log_{10}CPV) - 7{,}41$$

$$\text{y}(m^3\text{de madera por ha y año}) = (5{,}3 \times log_{10}696{,}66) - 7{,}41 = 7{,}65\ m^3/año$$

And the zones are classified into seven classes that are detailed below:

Table 14: Limitations on forest productivity. (Own elaboration)

Productividad	Clase	Limitaciones para el crecimiento de bosques productivos
y>9	Ia	Sin Limitaciones
y>7,5	Ib	Sin Limitaciones
6<y<7,5	II	Limitaciones débiles
4,5<y<6	III	Limitaciones moderadas
3<y<4,5	IV	Lim. moderadamente graves
1,5<y<3	V	Limitaciones graves
0,5<y<1,5	VI	Limitaciones muy graves
y<0,5	VII	Impedido el bosque productivo

Therefore, it is an area of class Ib without limitations for the growth of productive forests.

1.3.3.3.2. Turc Agricultural Potential Index

The Turc index indicates the potential agricultural production capacity that has a place depending on the climatic variables. It is obtained month by month and by means of the sum of monthly values (according to the time of permanence of the culture in the field) the value for the crop is obtained.

For its calculation, three factors must be established:

F_t = Thermal factor

$$F_t = \left[\frac{tm \times (60 - tm)}{1000}\right] \times \left[\frac{(t-1)}{4}\right] \qquad \text{If: } 1 < t < 5$$

$$F_t = 0 \qquad \text{If: } t \leq 1$$

$$F_t = \left[\frac{tm \times (60 - tm)}{1000}\right] \qquad \text{If } t \geq 5$$

Tm = average temperature of the month in ° C
T = mean temperature of the minimum of the month in ° C

F_h = Solar factor

The solar factor is the smaller value of the result of the two following expressions, provided that the lower value is positive, otherwise the solar factor takes as value 0 and the month is unproductive.

$$F_h = \text{máximo}[0 \text{ ó } \text{mínimo}\{F_{h1} \; y \; F_{h2}\}]$$

$$F_{h1} = \mathrm{N} - 5 - \left[\frac{\Phi}{40}\right]^2$$

$$F_{h2} = 0{,}03 \times [R_s - 100]$$

N = mean maximum insolation in hours / day
Ø = Latitude in degrees
Rs = solar radiation in the soil (ly / day), evaluated by the method of Turc

$$R_s = R_A \left[0{,}18 + 0{,}62 \times \left(\frac{\mathrm{n}}{\mathrm{N}}\right)\right]$$

RA = Global radiation (l / day) according to ANGOT
n = Number of effective hours of sun per day

Fs = Dryness factor

In irrigation, which is the case of this project, Fs = 1 since there is no water deficit.
The monthly Turc index is obtained by the product of the three factors obtained for the month:

$$\mathrm{CA} = F_t \times F_h \times F_s$$

The one of the considered period is evaluated by the summation:

$$CA_{anual} = \Sigma F_{ti} \times F_{hi} \times F_{si} \; ; de \; i = I \; a \; i = XII$$

ETP according to Turc

For the calculation, the ETP according to Turc is needed, which is given by the expression:

$$\mathrm{ETP}_i = f_i \times [tm_i/(tm_i/15)] \times [R_s + 50] \times c_i$$

Fi = monthly correction factor: 0.37 for February; 0.4 for the rest of the months
Tmi = Average monthly temperature in ºC
Ci = Correction factor for arid zones, with displacement of masses of warm air, as a function of the relative humidity of the month.

$c_i = 1$ If: HR%> 50%

$c_i = 1 + \left[\frac{(50 - HR_i)}{70}\right]$ If HR% <50%

The following table shows the data obtained:

Table 15: Data for the calculation of the agricultural potential index of Turc. (Own elaboration)

	ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	JULIO	AGOSTO	SEPTIEMBRE	OCTUBRE	NOVIEMBRE	DICIEMBRE	AÑO
tm(ºc)	27,9	29,1	30,5	29,7	27,4	26,8	26,8	26,4	26,7	27,0	26,2	27,1	
t(ºc)	18,2	20,0	22,0	21,1	20,2	20,7	21,9	20,9	20,5	20,1	19,3	18,8	
N	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	
n	8,0	7,4	6,1	7,0	5,0	4,7	4,3	2,5	5,0	6,3	7,0	8,0	
R_A	642	732	834	902	930	934	930	902	843	755	656	610	
R_s(cal/cm^2)	380,9	411,6	413,0	488,6	407,7	394,9	374,0	278,9	369,5	381,7	355,3	361,9	
F_t	0,896	0,899	0,900	0,900	0,893	0,890	0,890	0,887	0,889	0,891	0,886	0,892	
F_{h1}	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	
F_{h2}	8,4	9,3	9,4	11,7	9,2	8,8	8,2	5,4	8,1	8,4	7,7	7,9	
F_h	6,96	6,96	6,96	6,96	6,96	6,96	6,96	5,37	6,96	6,96	6,96	6,96	
HR%	46	43	45	51	61	71	79	79	73	68	57	54	
c	1,057	1,100	1,071	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
f	0,40	0,37	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	
P	5	8	27	56	156	150	239	228	155	113	48	12	
ETP_{Turc}	118,5	124,0	133,0	143,1	118,3	114,1	108,7	83,9	107,4	111,0	103,1	106,1	
P-ETP_{Turc}	-113,5	-116,0	-106,0	-87,1	37,7	35,9	130,3	144,1	47,6	2,0	-55,1	-94,1	
R	0,0	0,0	0,0	0,0	37,7	73,6	80,0	80,0	80,0	80,0	24,9	0,0	
VR	0,0	0,0	0,0	0,0	37,7	35,9	6,4	0,0	0,0	0,0	-55,1	-24,9	
ETR	5,0	8,0	27,0	56,0	118,3	114,1	108,7	83,9	107,4	111,0	103,1	36,9	
F	113,5	116,0	106,0	87,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	69,2	
$0,3*ETP_{Turc}+50$	85,6	87,2	89,9	92,9	85,5	84,2	82,6	75,2	82,2	83,3	80,9	81,8	
X	85,6	87,2	89,9	92,9	85,5	84,2	82,6	75,2	82,2	83,3	80,9	81,8	
(X-F)/X	-0,3	-0,3	-0,2	0,1	1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,2	
Rep	0,0	0,0	0,0	-0,2	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	
F'S	-0,3	-0,3	-0,2	-0,1	0,9	1,0	1,0	1,0	1,0	1,0	1,0	0,2	
F_s	0,0	0,0	0,0	0,0	0,9	1,0	1,0	1,0	1,0	1,0	1,0	0,2	
CA	0,0	0,0	0,0	0,0	5,5	6,2	6,2	4,8	6,2	6,2	6,2	0,9	**42,1**
$CA_{regadio}$	6,2	6,3	6,3	6,3	6,2	6,2	6,2	4,8	6,2	6,2	6,2	6,2	**73,1**

Therefore, the agricultural potential of Turc for rainfed is 42.1 and in irrigated land is 73.1. Taking into account a coefficient of 0.6 t / ha.year, the final production is 25.26 t / ha.year in rainfed and 43.86 t / ha.year in irrigation.

1.3.3.4. Climate Classification

The classifications establish a number of categories according to climatic parameters, to limit ecosystems (steppe, desert and other) and latitudinal geographic strips (tropical, polar and other climates).

The climatic classification of Köppen by Unesco FAO and the agroclimatic classification of Papadakis for the given area are described below.

1.3.3.4.1. Classification of Köppen

It is based on average monthly or annual temperatures and on average annual or monthly precipitation. It is divided into 5 categories (A; B; C; D; E) each with a subgroup and a possible subdivision.
The following is the necessary data for the project area:

Tm1ºC = Average temperature of the coldest month
P (cm) V6 = Average maximum precipitation of the six warmest months
P (cm) i1 = Average minimum precipitation of the coldest six months

Table 16: Data for the classification of Köppen. (Own elaboration)

tm_1(ºC)	26,2
$P(cm)_{v6}$	48
$P(cm)_{i1}$	156

Tm1> 18ºC so it is an area of Tropical Rainy A category. On the other hand, P (cm) V6> 10.P (cm) i1 and the subgroup is w Winter. This means that the dry season extends throughout the winter.

1.3.3.4.2. UNESCO Classification FAO

FAO makes groupings taking into account the thermal and aridity characteristics. Here is the data needed to determine the group of the given zone:

Tm1ºC = Average temperature of the coldest month

Tm1 ° C = 26.2

Therefore, it belongs to group 1, warm subgroup, axeric sub-division of warm equatorial type.

1.3.3.4.3. Papadakis Agroclimatic Classification

The classification of Papadakis aims to respond to the ecology of crops, redefining the climates according to relevant variables as to the viability of commercial crops. To do this, the type of winter is defined, type of summer, thermal regime and water regime to

determine the type of climate. In this case the ETP calculated by the Papadakis method is used.

The following is the data and calculations needed to determine this classification:

Type of Winter:

It defines the severity of the cold season as a function of the average temperature of absolute minimums of the coldest month (t'a1), the average temperature of minimums of the coldest month (t1) and the average temperature of maximums of the coldest month (T1)

T'a1> 7 ° C
T1 = 18.2 ° C> 18 ° C
T1 = 31.6 ° C> 21

Strictly, the data shown indicate that the type of winter is Equatorial (Ec).

Equatorial Winter (Ec) is defined as free from frost and warm enough to allow the cultivation of oil palm, coconut, and rubber tree.

Type of summer:

It defines the summer heat and in this case it is calculated taking into account the following data:

EmLH = Minimum freezing season in months
Tm = Average of the average maximum temperatures of the 6 warmest months
T12 = mean of maximums of the warmest month
T12 = mean of the lowest of the warmest month

We have:

EmLH = 12 months> 4.5
Tm = 37.08 ° C> 25
T12 = 38.9 ° C> 33.5
T12 = 22

Therefore, the summer type is Gossypium Warm (G) ie it is long enough and warm enough to grow cotton.

Thermal Regimen:

The thermal regime corresponds to the climatic potentiality of the cold season and the warm season.
In this case, having an equatorial winter (Ec) and a warm summer Gossypium (G), the thermal regime is Equatorial Warm (EQ).

Water Regime:

The water regime defines the natural availability of water for the plants.
It is based on the following parameters:

Annual moisture content $lh = P/ETP$

Ihi = monthly moisture index $lh_i = P_i/ETP_i$ if $P_i > ETP_i$

Or $lh_i = (P_i + |VR_i|)/ETP_i$ if $P_i < ETP_i$

Wet months $P_i > ETP_i$

Intermediate months $P_i > 0{,}5 \times ETP_i$

Dry months $P_i < 0{,}5 \times ETP_i$

Washing rain $ln_i = \Sigma_{m=1}^{12}(P_i - ETP_i)$ if $P_i > ETP_i$

The following table shows the results obtained:

Table 17: Data for calculation of the water regime according to Papadakis. (Own elaboration)

	ENERO	FEBRERO	MARZO	ABRIL	MAYO	JUNIO	JULIO	AGOSTO	SEPTIEMB	OCTUBRE	NOVIEMBR	DICIEMBR	Total
P	5	8	27	56	156	150	239	228	155	113	48	12	
$ETP_{Papadakis}$	265,2	264,9	259,9	234,6	190,1	153,7	132,1	138,5	161,5	180,7	170,2	219,3	
$P\text{-}ETP_{Papadakis}$	-260,2	-256,9	-232,9	-178,6	-34,1	-3,7	106,9	89,5	-6,5	-67,7	-122,2	-207,3	
R	0	0	0	0	0	0	80	80	73,5	5,8	0	0	
VR	0	0	0	0	0	0	80	0	-6,5	-67,7	-5,8	0	
Ih	0	0	0,1	0,2	0,8	1	1,8	1,6	1	1	0,3	0,1	
Mes húmedo	0	0	0	0	0	0	1	1	0	0	0	0	
Pm+Rm-1	5	8	27	56	156	150	239	308	235	186,5	53,8	12	
0,5xETP	132,6	132,5	130	117,3	95	76,8	66,1	69,3	80,7	90,3	85,1	109,7	
Mes intermedio (1) o seco (0)	0	0	0	0	1	1	1	1	1	1	0	0	
Ln	0	0	0	0	0	0	106,9	89,5	0	0	0	0	196,33

The data obtained indicate that it is a dry Monzonic water regime (Mo) since ln <0.2xETP and 0.44 <lh = 0.5 <0.88.

Climate Units:

Finally, the climatic units and their subdivisions are defined with the criteria of the thermal regime and the water regime. In this way, because of the equatorial thermal regime (EQ) and the dry Monzonic water regime (Mo), the climatic unit of the given zone is Tropical and the subunit is warm-equatorial-tropical or semi-arid.

1.3.4. Climate Change and El Niño Phenomenon

It is important to bear in mind that all the data provided above have been taken since the late 1970s and early 1980s, and therefore do not reflect the change in the climate in recent years, especially with regard to the Boy.

Until the beginning of the 20th century it was thought that the cycle of droughts that repeated cyclically every 3 to 5 years affected only Central and South America. Thanks to advances in measurement and exchange of information, it is now known that El Niño is a global phenomenon, which is repeated following complex cycles, and that we still have much to know about a phenomenon that directly and indirectly affects practically the entire world population. There is a contrasting phenomenon, whose name is La Niña. It is known that both phenomena begin with the marine currents of the South Pacific. El Niño forms when the temperature of the Pacific Ocean rises. Usually the trade winds push the hot water westward, crossing the Pacific towards Asia, while the cold water moves towards the Pacific coast of Central America. But when temperatures in the east and center of the Pacific are consistently higher than usual, a wave of winds from the west comes. This generates a large stream of hot water that moves slowly towards South America, and thus the Niño is born, a phenomenon that can last until more than a year, being a key factor in the appearance of deserts like the one of Atacama and producing a chain reaction that ends up affecting the marine and air currents of the whole planet. These changes in the air and sea currents have as a consequence serious droughts in specific areas of the planet, and floods in others, which unfortunately are usually the areas with the least resources. La Niña occurs at the end of the Child's cycle and return the marine currents of the Pacific to move normally. The first year in which it does, it does so with more force, and the final consequence of the chain reaction are torrential rains and floods, more important floods if they fit, because the soil is very dry, crust has formed And infiltration is minimal.

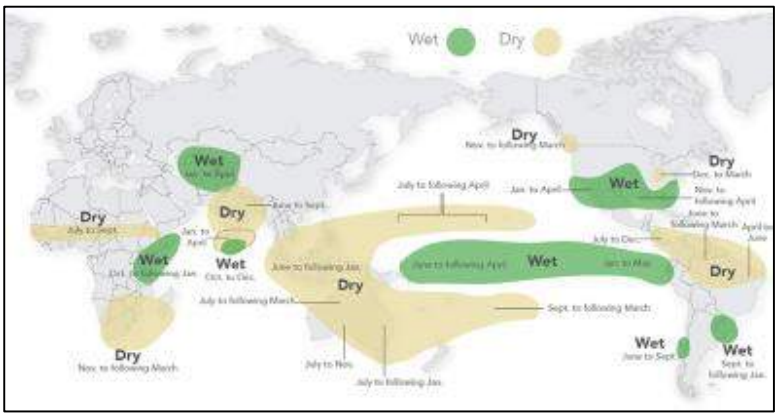


Figure 1: El Niño effects in the world (wet: floods, dry: droughts). (Source: Google Images)

In Africa, the most affected area is the east, and the Sahel countries, but especially the horn of Africa. These are poor, conflictive and sometimes overcrowded regions, which further accentuates the problem, while restricting solutions.
The last time the phenomenon of the Child occurred was in the year 2015, and still in the summer of 2016 it was noticed in some regions. Ethiopia is one of the countries most

vulnerable to El Niño, not only as a member of the horn of Africa but because it is an overcrowded country where 70% of the population lives on agriculture. It is one of the 20 priority countries for FAO within its El Niño response plan.

When the expected summer rains of 2015 did not arrive, the farmers had to feed themselves, and their cattle, with some of the seeds they were going to plant. In some regions such as the Somali region and the Afar region, where the population is largely pastoral nomadic, the drought was so severe that there were only ten million people at risk of famine in those two regions according to FAO in the summer of 2016 And predictably until after the summer rains of 2017. But unlike the drought that occurred during the 1980s in the same country, which was very mediatic and ended with the removal of the debt by Bill Clinton on behalf of the States United, this time Ethiopia has wanted to be more prepared. With the support of FAO, it has created mechanisms to alleviate the effects of a drastic decrease in production in the country, which ultimately aims to keep prices at an adequate level. At the time when this project is written, Ethiopia lives in a convulsive age, it is possible that this was the last straw that filled a glass full of repression, censorship, nepotism, poverty and frustration, or at least was already in the glass.

In Gambella it is difficult to compare productions from one year to another since there is no production or performance data. It is very difficult to find industrial scales and therefore the measure that is taken is the 50L bag, approximately 35 kg. Not surprisingly, during the stay in this region had the opportunity to interview many farmers, and all confirmed that in 2015 production was half of normal, according to them due to the few rains that occurred in summer.

However, in the summer of 2016, in this part of Ethiopia and throughout the center of the country, which is situated above 1800 m above sea level, the La Niña phenomenon occurred. The first rains of the year at the beginning of May arrived in a torrential way, when the soil was drier and the lower infiltration, producing floods that took many lives ahead. Another indirect consequence is the stagnation of water in puddles and the appearance of mosquitoes with the consequent increase in cases of malaria and yellow fever, which according to doctors interviewed this year were very virulent. In addition, the farmers who had already planted saw all the seeds being swept by water, which means ruin for most of them.
In short, it is important to take into account the El Niño factor when drawing up a medium-term plan, and to follow the recommendations of the international organizations, especially to follow regularly the warnings of catastrophes and emergencies.

1.4. HYDROGRAPHICS

Due to its steep orography, Ethiopia is one of the countries with the largest number of rivers and lakes. Of them, it is possible to emphasize on the one hand Lake Tana. Of the size of the community of Madrid, it is the largest in the country and from it is born the blue Nile River that contributes 80% of the Nile water in the Aswan dam in Egypt. A conflict that is not having much media impact is that of Egypt and Ethiopia for the construction of the blue Nile dam in Ethiopia, which would seriously affect Egypt and Sudan. On the other hand, they are of special importance to the Rift Valley ecosystem and the large mammals inhabiting them, the great lakes of the south, which line the entire valley beyond Kenya to the great lakes of Victoria, Tanganyyka And Malawi.

Gambella is located in the BARO-AKOBO sub-basin in the Nile River basin. The basin is named after the two most important rivers that cross the region, the Baro River, which runs from the northeast to the northwest, and the Akobo River Makes the border between South Sudan and Ethiopia in its route through Gambella. The Akobo River is a tributary of the Pibor River. It is born south of Gambella and continues along the border, towards the northwest, about 40 km forming a tortuous road until reaching the river Pibor, which continues northwards serving as a border until reaching the river Baro, where the river passes to Be called Sobat river. The Baro River, which is the junction of the rivers Birbir and Geba, comes from the region of Oromia, not far from the Gambella border, and covers about 200 km, including the city of Gambella from where the river is navigable to Khartoum, Until arriving at the border with Sudándel south where it is turned towards the south making border for 100 km until reaching the river Pibor.

Figure 2: Nile Watershed (Source: Google Images)

Figure 3: Watersheds of Ethiopia. (Source: Google Images)

The types of soil that exist in the region have a high clay content which makes drainage difficult. During the rainy season, it is common for dangerous floods to occur after a downpour, which can lead to entire villages and the lives of many people. This usually occurs with a frequency of once a month, or two in the months of July and August, which gives an idea of the seriousness of the matter.

In addition, during the rainy season most of the region is flooded, which makes it impossible to access many parts of the region, and incommunicado to much of the population. Another part of that population migrates to less boggy areas, or even simply live soaked during the rainy season. Large mammals also migrate to areas of South Sudan during this time.

The land is located 14.7 km south by road from the Don Bosco school, on the left bank of the Baro River, on an elbow to the east. It is intended to pump water from the river directly to the crop. The Baro and its tributaries collect water of 41 400 km2 and has a mean flow in the mouth of the river of 241 m3 / s throughout the year, which allows not to be dried at any time. It should be noted that the Baro River contributes 10% of the Nile water in the Aswan Dam during the rainy season.

1.5. EDAPHOLOGICAL

1.5.1. Obtaining data

Due to the conflicts that occurred during the months of April and May in the Gambella region, it was not possible to complete the laboratory analysis of soil samples from the land. However, the information obtained from different sources, mostly from FAO and the ISRIC (global soil information system) in different formats, could be compared in the field. In both cases these are predictions made from soil studies carried out at key points, being in this case the closest and with similar characteristics the one realized in the city of Itang, in the region of Gambella, that is to 42 Km from the property on the edge of the Baro River.

Figure 4: Location of the sample collection area with respect to the farm. (Source: Google Earth)

1.5.2. Introduction

The Ethiopian orography, along with the climate, has conditioned to a great extent the great edaphological diversity of the area, which is distributed by geography, at first sight in a disorderly way. Thus, according to the SOIL ATLAS OF AFRICA and following the World Reference Base for soils, you can find islets of Andosols, Luvisols, Histosols, Cambisols, Chernocems, Calcisols, Vertisols, Nitosols, Leptisols, Fluvisols, Alisols and others. In the eastern part of Ethiopia, dominated by a desert landscape, the Leptisols are the majority soils. In the center of the country, where the average altitude is 2000 msnm, the Nitosols abound. In the Gambella region the dominant soils are in order from highest to lowest, Haplic Vertisols, Eutric Fluvisols, Haplic Alisols, Umbric Nitosols, and Dystric Leptisols. The land is located in an Alisols area, near the edge with another Nitosols area. It must be taken into account that being predictions can be given any type of soil in the terrain, even several.

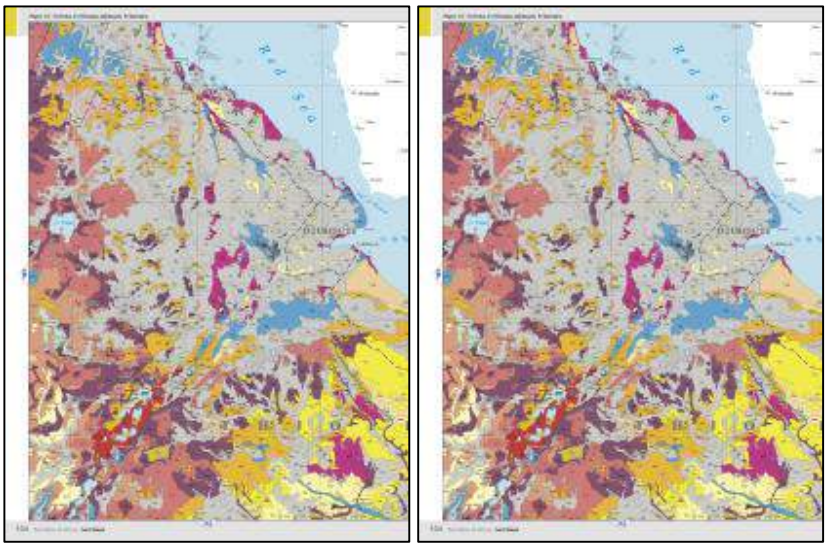


Figure 5: Soil map of Ethiopia. (Source: Soil Atlas of Africa)

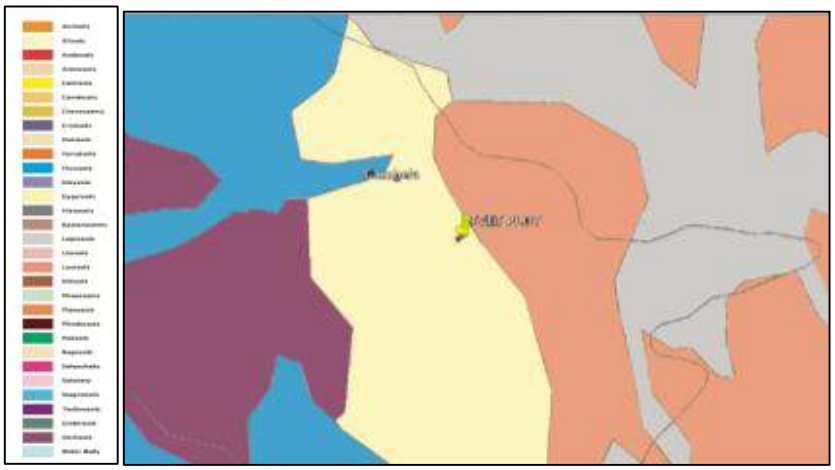


Figure 6: Map of soils of the study area and legend. (Source: Soil Atlas of Africa)

The summary description of the WRB 2014 definitions is then extracted for each of the soils that can be found in Gambella and therefore on the farm:

• **Brief description of Vertisols**

Connotation: Scattered heavy clay soils; From the Latin vertere, to turn.

Parental material: Sediments containing a high proportion of expandable clays or expandable clays produced by neoformation due to the weathering of rocks.

Environment: Depressions and flat to undulating areas, mainly in tropical and subtropical climates, semi-arid to sub-humid and wet with alternating marked dry and humid seasons. The climax vegetation is of savannah, natural prairies and / or forests.

Development of the profile: The alternating expansion and retraction of expandable clays give rise to deep cracks in the dry season and the formation of slickensides and wedge-shaped structural elements in subsurface soil. Expansion-retraction behavior can cause gilgai microrelief to form, especially in dry climates.

• Short description Fluvisols

Connotation: Soils developed in fluvial deposits; From the Latin fluvius, rio.
Parental material: Predominantly recent fluvial, lacustrine and marine deposits.
Environment: River plains and river basins, valleys, lake depressions and marshes on all continents and in all climatic zones; There is no water table or high salt content in the surface soil; Many Fluvisols in natural conditions are flooded periodically.
Profile development: Profiles with evidence of stratification; Weak differentiation of horizons, but may have a different surface horizon in mind.

• Short description of Alisols

Connotation: Soils with low base saturation at a certain depth; From Latin alum, alum.
Parent material: In a wide variety of parent materials. Most of the Alisols, recorded so far, appear in weathering products of basic rocks and unconsolidated materials.
Environment: Generally in mountainous or wavy topography, in humid climates tropical, humid subtropical and monsoon in addition humid temperate climates.
Development of the profile: Edafogenetic differentiation in the clay content, with a lower content in the upper layer and a higher content in the subsurface soil, leaching of basic cations due to the humid environment without an advanced weathering of high activity clays. Loss of iron oxides, together with clay minerals, can lead to a whitish eluviation horizon between the surface horizon and the arc subsurface horizon, but the Alisols lack the Retisols' rheological properties.

• Short description of Nitisols

Connotation: Deep, well-drained tropical red soils with a clayey sandy horizon that has a typical structure of angular blocks that break in polyhedral shapes, flat edges or nuciform elements with, in a moist state, the faces of the bright aggregates; From Latin nitidus, brilliant.
Parental material: Finely textured weathered products of basic or intermediate mother rock, in some regions rejuvenated by recent additions of volcanic ash.
Environment: These soils are mainly from flat to mountainous lands under tropical forest or savanna vegetation.
Profile development: Reddish brown or reddish brown soils with a subsurface horizon of high stability of aggregates. The set of Nitisols clay is dominated by Caolinite / (meta) Haloisite. Nitisols are rich in Fe and have little water-dispersible clay.

• Short description of Leptosols

Connotation: Thin soils; From Greek leptos, slender.

Parental material: Various types of continuous rock or unconsolidated materials with less than 20% (by volume) of fine earth.
Environment: Mainly high or medium altitude terrain with a strong topographic slope. Leptosols are found in all climatic zones (many of them in hot or cold dry areas), particularly in heavily eroded areas.
Profile development: Leptosols have continuous rock at or very close to the surface or are extremely rocky. In weathered calcareous material can have a mobile horizon.

1.5.3. Soil analysis

The following data have been obtained from the FAO and SoilsGrid Map database of the ISRIC, and are a prediction based on an edaphological analysis conducted in the outskirts of the city of Itang, 42 km from the farm.

All the possible data have been verified on the spot with the tools with which they were available. Next, it is detailed the source from which each data has been obtained besides the calculations to obtain the rest of properties, the results obtained in field and the interpretation for each property of the floor.

1.5.3.1. Physical properties

1.5.3.1.1. Texture

The texture of the soil gives us information about the physical fertility of the soil, ie its water retention capacity, compaction risk, infiltration and other relevant data. It is calculated by means of the texture triangle with the percentage data of sand, silt and clay. In this case the SOIL GRID data from the ISRIC were obtained. The graphs available in this database are shown below for percent sand and clay silt, bulk density and percentage of coarse elements:

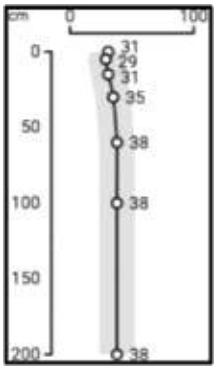


Figure 7 : Percentage of clay in the soil. (Source: ISRIC)

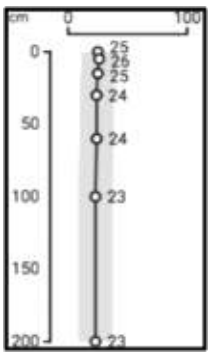


Figure 8 : Percentage of silt. (Source: ISRIC)

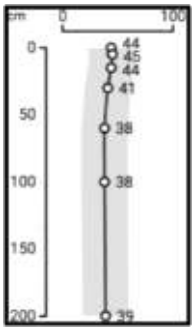


Figure 9 : Percentage of sand. (Source: ISRIC)

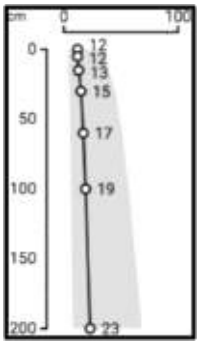


Figure 10 : Percentage of coarse elements in the soil. (Source: ISRIC)

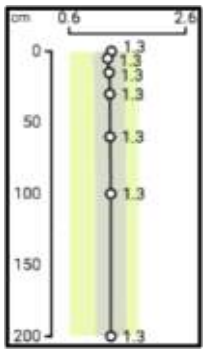


Figure 11 : Bulk density. (Source: ISRIC)

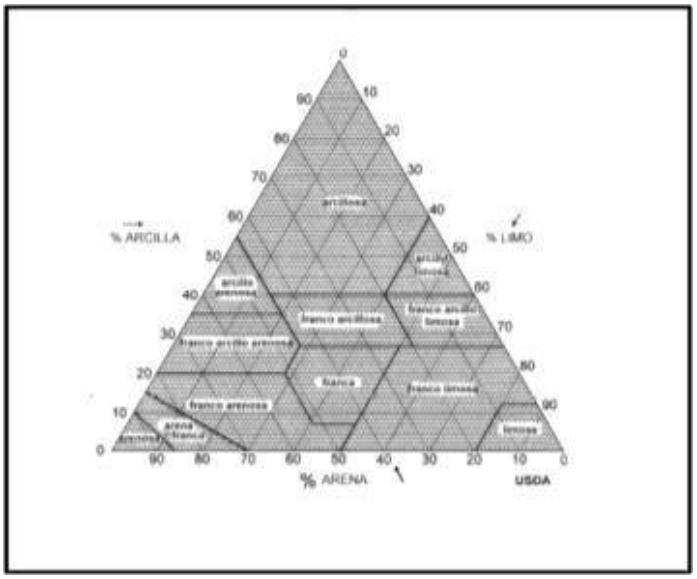


Figure 12: Textural class according to USDA. (Source: www.usda.gov)

Table 18: Physical properties of the soil. (Own elaboration)

PROPIEDADES/ PROFUNDIDAD (CM)	0	5	15	30	60	100	200
ARCILLA (%)	31	29	31	35	38	38	38
LIMO (%)	25	26	25	24	24	23	23
ARENA (%)	44	45	44	41	38	38	39
ELEMENTOS GRUESOS (%)	12	12	13	15	17	19	23
DENSIDAD APARENTE (t/m3)	1,3	1,3	1,3	1,3	1,3	1,3	1,3
CLASE TEXTURAL (USDA)	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA

As can be seen in the summary table, the entire profile corresponds to the USDA clay loam textural class. These soils usually have:

- A high chemical fertility, according to mineralogy
- Specific high surface
- High CIC, according to mineralogy
- AWRC medium high
- Low permeability
- High micro porosity
- High compaction risk
- Difficulty of tilling
- High moisture retention energy
- High thermal inertia
- Difficulty penetrating roots

In the field it was possible to verify that the soil is indeed clay-free according to the Tamés method modified by cover. That is to say, that a filament of 3 mm of thickness could be made and doubled it to form a ring, and could make another filament of 1 mm of thickness, but could not bend in the form of ring.

Thick elements:

In addition, depending on the percentage of coarse elements, we can describe a number of advantages such as increased permeability, decreased erosion, potential release of minerals and other, or disadvantages, hinder the movement of wildlife, abrasive effect on implements, Deformations in growth of thick roots and others. According to the cataloging by C. Dorronsoro, 2002, if 10% <% EG <30% is a favorable soil. (Very favorable, favorable, unfavorable and very unfavorable). It could be verified that there are many rocks in the ground from medium to small, with the edges more polished the closer to the river due to the effect of water erosion, and although the percentage of real thick elements is a little larger, it is still In the favorable range.

Compaction:

The apparent density gives us an idea of soil compaction. The more compacted a soil is, the less structure it has and the more difficulties its roots have to develop, as well as causing problems of infiltration, erosion and others. *According to values of the bulk density that mark the beginning of the restriction and the limitation to root development (Soil Surrey Staff, 1996)*, for soils with 35-45% clay, the beginning of the restriction starts at 1.49 g / cm3 , And for clay loam soils the restriction begins at 1.54 g / cm3. The apparent density of the soil is 1.3 g / cm3 throughout the profile so there are no compaction problems, the soil has a good structure and the roots do not have severe impediments. However, it should be borne in mind that this is a very clayey soil with possible accumulations of clay in the subsurface horizons by leaching, and it is possible that an argic horizon is created as in the Alisols.

Indeed, on the ground it was verified that the soil is spongy, but in the lower horizons, where there is a greater accumulation of clays, the soil is more compact and although it is not difficult to excavate, the difference between the surface and these horizons is made evident.

Encrustment index:

The index of encostramiento gives us information about the risk of sealing of the soil, and the consequent low or nil infiltration and oxygenation of the soil. If a crust forms on the surface layer it increases the rate of soil erosion and decreases the biological activity. The index of encostramiento is calculated by the following expression:

$$I_c = [(1{,}5 \cdot \mathrm{Zf} + 0{,}75 \cdot \mathrm{Zc})/(\%\mathrm{Ac} + 10 \cdot \%\mathrm{MO})] - \mathrm{C}$$

Zf =% fine silt (0.002-0.02 mm)
MO =% organic matter

Zc =% thick slime (0.02-0.05 mm)
Ac =% clay
C = 0 if pH (1: 2.5) ≤ 7
C = 0.2 · (pH-7) if pH (1: 2.5)> 7

$$I_c = \left[\frac{1{,}5 \cdot 25 + 0{,}75 \cdot 0}{31 + 10 \cdot 3{,}5}\right] - 0 = 0{,}57$$

In this case, the worst case has been assumed, ie the total silt corresponds to fine silt (0.002-0.02 mm), and the percentage of organic matter is 5 cm deep. According to Soltner's 1990 cataloging in Saña, MAPA, 1996, with an Ic of 0.57, it is a soil with a low tendency to form crust because it is below 1.6. On the ground it was seen that there was no area with superficial crust.

1.5.3.1.2. Water in the floor

Next, the data obtained in relation to the water in the soil, and the calculations made to obtain them, are detailed.

Porosity:

The porosity is obtained from the bulk density by:

$$P = \left(1 - \frac{D_a}{D_r}\right) \times 100$$

$$P = \left(1 - \frac{1{,}3}{2{,}65}\right) \times 100 = 50{,}94$$

The porosity is 50.94%, meaning that for each cubic meter of soil there is 0.5094 m3 of pores. This corresponds to the saturation point, when all the pores are filled with water.

Wilt Point, Field Capacity and AWRC:

The wilting point can be obtained empirically in the laboratory, applying a suction pressure of 1500kPa and calculating the amount of water retained, or by regression equations from the data of texture and organic matter. In this case, a graph with the wilting points along the SOILGRID profile has been obtained. In addition, this graph has been compared with the results obtained by a regression equation (Rawls and Brakensiek, 1985, reproduced in Maidment, 1992). To obtain the field capacity the regression equation has been used directly. To obtain the AWRC is sufficient to subtract the WP to the FC.

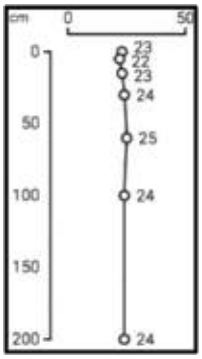


Figure 13: Wilting point. (Source: ISRIC)

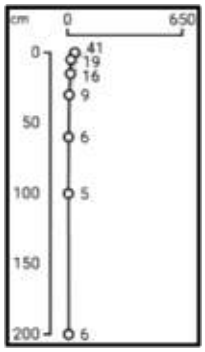


Figure 14: Organic carbon per thousand. (Source: ISRIC)

$$\text{M.O.}(\%) = \frac{\text{C.org}\left(\frac{\text{g}}{\text{kg}}\right).\times 1{,}72}{10}$$

$$WP(-1500kPa) = 0{,}026 + 0{,}005 \times \%Clay + 0{,}0158 \times \%organic\ matter$$

$$\text{FC}\ (-33\text{kPa}) = 0{,}2576 - 0{,}002 \times \%\text{Sand} + 0{,}0036 \times \%\text{Clay} + 0{,}0299 \times \%\text{organic matter}$$

$$\text{AWRC}\left(\frac{cm^3}{cm^3}\right) = \text{FC}\left(\frac{cm^3}{cm^3}\right) - \text{WP}\left(\frac{cm^3}{cm^3}\right)$$

Table 19: Water properties of the soil. (Own elaboration)

PROPERTIES / DEPTH (CM)	0	5	15	30	60	100	200
CLAY (%)	31	29	31	35	38	38	38
SILT (%)	25	26	25	24	24	23	23
SAND (%)	44	45	44	41	38	38	39
Organic carbon (g / kg)	41	19	16	9	6	5	6
Organic matter (%)	7,052	3,268	2,752	1,548	1,032	0,86	1,032
WP (cm3 / cm3) Calculated	0,292	0,223	0,224	0,225	0,232	0,230	0,232
WP (%) Graphic	23	22	23	24	25	24	24
FC (cm 3 / cm 3)	0,492	0,370	0,363	0,348	0,349	0,344	0,347
AWRC (cm 3 / cm 3)	0,200	0,147	0,139	0,122	0,117	0,115	0,115

According to the cataloging of Modified C. Dorronsoro, all horizons have a very favorable AWRC for being all above 100mm.

1.5.3.2. Chemical Properties

1.5.3.2.1. pH

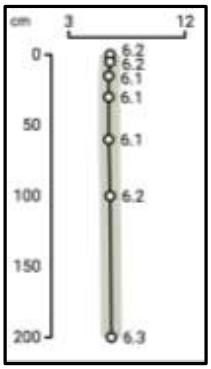


Figure 15: PH in soil water. (Source: ISRIC)

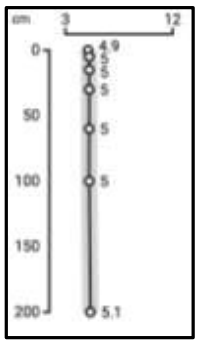


Figure 16: PH in soil KCl. (Source: ISRIC)

As can be seen in the above figures, the pH in water of the soil is about 6.2. As expected, according to Porta et al., 1999, it is a slightly acid soil with maximum availability of

nutrients. However, in relation to its texture, according to the standard of pH diagnosis as a function of the texture of Magny and Baur-1962 and Guigou et.al 1989, with modifications, it is a soil that is too acidic to have more than 25% Of clay and a pH below 7. Moreover, it can be seen that there is a considerable difference between the pH in water and the pH in KCl, which means that the change complex is mostly occupied by H + ions, and therefore That its saturation percentage by bases V is low. To be taken into account at the time of fertilization since the H + ions can be displaced and drastically lower the pH of the soil. In this type of soil could be cultivated acidófilos like the potato, the tobacco, the rye or the oats, and some plants neutral rows like the corn, the clover or the wheat.

1.5.3.2.2. Cation Exchange Capacity

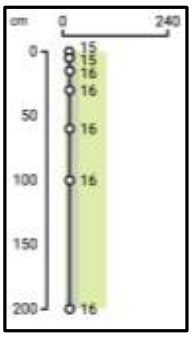


Figure 17: CEC of the soil. (Source: ISRIC)

Table 20: Table of CEC interpretation. (Own elaboration)

CIC (cmolc/kg)	CALIFICATIVO
<6	Muy débil
6-10	Débil
10-20	Medio o normal
20-30	Elevada
>30	Muy elevada

The cation exchange capacity is the amount of nutrients that the humic clay complex can retain. Soils with low cation exchange capacity can retain few cations and therefore can absorbe lower nutrient (so more frequent doses of fertilizers are needed) than soils with high cation exchange capacity.
As you can see in the previous table, the soil has a medium or normal CIC.

1.5.3.2.3. Base Saturation

The percentage of saturation by bases (V%) is the proportion of the change complex occupied by the cations sodium, calcium, magnesium and potassium. It is calculated by summing the positive charges and dividing by the cation exchange capacity. ISRIC SoilGrid interchangeable elements data have been obtained:

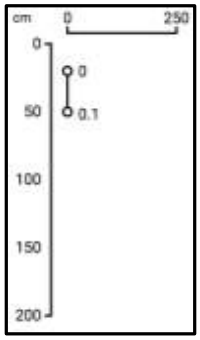


Figure 18: Exchangeable Sodium. (Source: ISRIC)

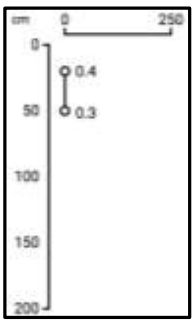


Figure 19 : Exchangeable potassium. (Source: ISRIC)

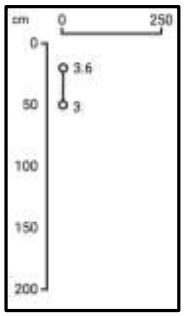


Figure 20: Exchangeable Calcium. (Source: ISRIC)

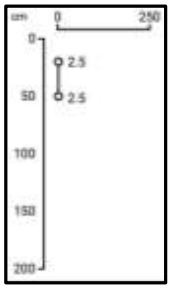


Figure 21: Exchangeable magnesium.. (Source: ISRIC)

$$V(\%)15cm = \frac{\Sigma([Na^+] + [Ca^{2+}] + [Mg^{2+}] + [k^+])}{CIC} \times 100 = \frac{6{,}5}{16} \times 100 = 40{,}625$$

$$V(\%)50cm = \frac{5{,}9}{16} \times 100 = 36{,}875$$

The higher the saturation value in bases (non-acidic cations), the easier and faster the displacement of the cations in the exchange complex and the greater the availability for plants. In this case, according to the table of interpretation of bases saturation of C. Dorronsoro, we find in the unfavorable range, between 50% and 20%, what confirms the deduced of the difference between pH in water and pH in KCl.
In addition, in order for the soil to function properly and no element must exceed the following limits established by En Saña, in MAPA 1996:

Table 21 : Interpretation table for calcium, potassium and magnesium. (Own elaboration)

ELEMENTO/PROFUNDIDAD(cm)	15cm	50cm	LIMITES DEL CALIFICATIVO	CALIFICATIVO
Ca2+(%CIC)	22,5	18,75	16-33%	Bajo
Mg2+(%CIC)	15,625	15,625	>10%	Excesivo
K+(%CIC)	2,5	1,875	1,5-3%	Correcto

1.5.3.2.4. Exchangeable Sodium Ratio

Sodium soils produce problems of soil structure, fertility and toxicity. A soil is considered to be sodium when its percentage of exchangeable sodium (PSI) is greater than 5-15%. In this case the PSI is:

$$PSI(15\text{cm}) = \frac{[Na^+]}{CIC} \times 100 = \frac{0}{16} = 0$$

$$PSI(50\text{cm}) = \frac{0{,}1}{16} \times 100 = 0{,}625$$

On the other hand, the sodium absorption ratio (SAR) should be less than 13%:

$$SAR(15\text{cm}) = \frac{[Na^+]}{K_G \times ([Ca^{2+}] + [Mg^{2+}])} = \frac{0}{0{,}015 \times 6{,}1} = 0$$

$$SAR(50\text{cm}) = \frac{[Na^+]}{K_G \times ([Ca^{2+}] + [Mg^{2+}])} = \frac{0{,}1}{0{,}015 \times 5{,}5} = 1{,}21\ (mmolL)^{1/2}$$

Consequently, the soil of the estate is not a sodium soil.

1.5.3.2.5. Organic matter

Organic matter determines to a great extent the health of a soil. A fair amount of organic matter is essential for a biotic diversity in the soil that allows to make the most of available resources, through symbiosis beneficial to the crop. In this case, the total organic carbon data of the ISIL SOILGRID were obtained and the amount of organic matter was calculated as follows:

$$M.O.\% = \frac{C.org\left(\frac{g}{kg}\right)\times 1{,}72}{10}$$

The following table shows the percentage of M.O., and the diagnosis according to the standard of diagnosis of organic matter as a function of pH and texture, by Spring et. al. 1993:

Table 22 : Organic matter in the soil. (Own elaboration)

PROPIEDADES/ PROFUNDIDAD (CM)	0	5	15	30	60	100	200
Carbón Orgánico (g/kg)	41	19	16	9	6	5	6
Materia Orgánica (%)	7,052	3,268	2,752	1,548	1,032	0,86	1,032
Diagnóstico	Excesivo	Rico	Correcto	Muy pobre	Muy pobre	Muy pobre	Muy pobre

In general it can be said that it is a soil rich in organic matter, which is concentrated in the upper horizons, but with the leaching it reaches the subsurface horizon, which benefits deep-rooted species above all.

1.5.3.2.6. C / N ratio

"This relationship refers to the quality of organic matter. Ratios close to 10 are indicative of good humification of organic matter. Higher values may indicate that there has been a recent contribution of fresh organic matter or that, for some reason, the activity of the microorganisms is slowed down and the processes of mineralization and humification are slowed down. Too low values are also undesirable and can be indicative of situations of soil depletion or nitrogen accumulation due to low microbial activity or excessive nitrogen fertilization "(Saña et al, 1996).

In this case the amount of nitrogen in soil is shown in the following figure:

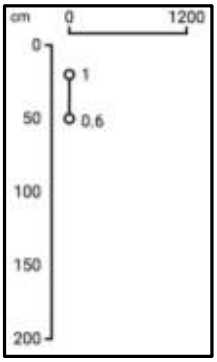


Figure 22 : Total nitrogen in the soil. (ISRIC Source)

Therefore, the carbon-nitrogen ratio in the soil and its qualification according to the scale of interpretation of the C / N ratio of Quéméner-1985 and Guigou 1989, is:

Table 23 : C / N ratio in the soil. (Own elaboration)

PROPIEDAD/PROFUNDIDAD	15cm	50cm
N (%)	0,1	0,06
C (%)	1,6	0,6
Relación C/N	16	10
Calificativo	Muy alta	Ligeramente alta

1.5.3.3. Soil fertility

1.5.3.3.1. Nitrogen

Most of the soil nitrogen is found in organic form, the store of that nutrient, assuming 97 to 99% of the total nitrogen. However, the plant is not able to absorb nitrogen in its organic form and it is necessary to mineralize the organic matter to obtain mineral nitrogen, which can be absorbed as ammonium, nitrite and nitrate.
In general, levels above 0.18% are considered excessive levels. The correct measurement is between 0.10% and 0.15% and below 0.08% are considered too low levels. In the case of the farm in question, the first horizons are at the correct levels.

1.5.3.3.2. Potassium calcium and magnesium

Like all other soluble minerals, potassium is in equilibrium in the soil solution. Such equilibrium, and therefore the availability of potassium to the plant, depends to a great extent on the texture of the soil. The clay particles are retained by the potassium ions releasing them gradually to the solution. Therefore, it is important to know the amount of potassium available and its rate of transfer to determine soil fertility. The more clayish the slower the cession, and, on the contrary, the more sandy, the faster the cession. In this case the potassium levels are correct so it does not require a previous enrichment, simply maintain the fertility, although the high content in clay indicates to us that the

availability of the mineral will be affected, reason why it will have to have it in Account when scheduling fertilization.

Magnesium levels are excessively high while calcium levels are low. Magnesium is potassium antagonist so this also has to be taken into account.

1.5.4. Summary table

Next, a table summarizing all the properties previously seen, as well as the data and diagnostics of each one:

Table 24: Summary of physical, chemical and soil fertility properties. (Own elaboration)

DEPTH (cm) / PROPERTIES	**0**	**5**	**15**	**30**	**60**	**100**	**200**
CLAY (%)	31	29	31	35	38	38	38
SILT (%)	25	26	25	24	24	23	23
SAND (%)	44	45	44	41	38	38	39
TEXTURAL CLASS (USDA)	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA	FRANCO ARCILLOSA
THICK ELEMENTS (%)	12	12	13	15	17	19	23
DIAGNOSTIC T.E.	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
BULK DENSITY (t / m3)	1,3	1,3	1,3	1,3	1,3	1,3	1,3
COATING	Sin riesgo	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx	xxxxx
COMPACTED	No	No	No	No	No	No	No
Organic carbon (g / kg)	41	19	16	9	6	5	6
Organic matter (%)	7,1	3,3	2,8	1,5	1,0	0,9	1,0
O.M. DIAGNOSTIC	Excesivo	Rico	Correcto	Muy pobre	Muy pobre	Muy pobre	Muy pobre
WP (cm3 / cm3) Calculated	0,292	0,223	0,224	0,225	0,232	0,230	0,232
WP (cm3 / cm3) Graphic	23	22	23	24	25	24	24
FC (cm 3 / cm 3)	0,492	0,370	0,363	0,348	0,349	0,344	0,347
AWRC (cm 3 / cm 3)	0,200	0,147	0,139	0,122	0,117	0,115	0,115
AWRC DIAGNOSIS	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable	Muy favorable
CEC (cmolc / kg)	15	15	16	16	16	16	16
CEC DIAGNOSIS	Normal	Normal	Normal	Normal	Normal	Normal	Normal
N (%)	xxxxx	xxxxx	0,1	xxxxx	0,06	xxxxx	xxxxx
C / N ratio	xxxxx	xxxxx	16	xxxxx	10	xxxxx	xxxxx
DIAGNOSTIC C / N	xxxxx	xxxxx	Muy alta	xxxxx	Ligeramente alta	xxxxx	xxxxx
Na + (cmol / kg)	xxxxx	xxxxx	0	xxxxx	0,1	xxxxx	xxxxx
PSI (%)	xxxxx	xxxxx	0	xxxxx	0,625	xxxxx	xxxxx
PSI DIAGNOSIS	xxxxx	xxxxx	No salino	xxxxx	No salino	xxxxx	xxxxx
Ca 2+ (cmolc / kg)	xxxxx	xxxxx	3,6	xxxxx	3	xxxxx	xxxxx
DIAGNOSIS Ca2 +	xxxxx	xxxxx	Bajo	xxxxx	Bajo	xxxxx	xxxxx
Mg 2+ (cmolc / kg)	xxxxx	xxxxx	2,5	xxxxx	2,5	xxxxx	xxxxx
DIAGNOSIS Mg2 +	xxxxx	xxxxx	Excesivo	xxxxx	Excesivo	xxxxx	xxxxx
K + (cmolc / kg)	xxxxx	xxxxx	0,4	xxxxx	0,3	xxxxx	xxxxx
DIAGNOSIS K +	xxxxx	xxxxx	Correcto	xxxxx	Correcto	xxxxx	xxxxx
V (%)	xxxxx	xxxxx	40,6	xxxxx	36,9	xxxxx	xxxxx
DIAGNOSIS V (%)	xxxxx	xxxxx	Desfavorable	xxxxx	Desfavorable	xxxxx	xxxxx
SAR ((mmolL) 1/2)	xxxxx	xxxxx	0	xxxxx	1,21	xxxxx	xxxxx
SAR DIAGNOSIS	xxxxx	xxxxx	No salino	xxxxx	No salino	xxxxx	xxxxx

1.5.5. Conclusion

In general terms, two groups of properties can be distinguished that have a number of advantages and disadvantages: Physical fertility, and chemical fertility.

The chemical fertility of the soil is good, however, it is necessary to maintain the levels by fertilization and / or fertilizer if one does not want to lose the good properties that it presents or to modify the pH until it affects the growth of the plants. One of the characteristics that favors this fertility is the high clay content of the soil. In addition, high clay content improves field capacity and, although the wilting point also increases, as the clay particles retain water molecules more strongly, AWRC is higher than in sandy soil. This allows for longer irrigations less times, which in the long run reduces costs. These two aspects, together with the good soil structure favored by the roots of the abundant vegetation and the microflora of the soil, are the basis for a healthy plot where the plants can develop their full potential.

It is important not to break the soil structure since the risk of compacting and affecting root growth is high because of the clay content. Another important risk that is accentuated by breaking down the soil structure is the risk of erosion and consequent loss of soil. It is a vicious circle in which, when the structure is lost, the soil compacts, the infiltration decreases, the erosion increases, the flora decreases and the soil structure decreases again. The latter is a major problem in recent years in Ethiopia due to rugged terrain and the sharp increase in land use without erosion protection. The problem has reached such a magnitude that the Ethiopian government, with the technical support of FAO, has established a plan for the fight against erosion and has functioned satisfactorily. This plan consists on the one hand to raise awareness among the local population and on the other to provide them with the tools and knowledge to combat erosion and desertification. Some of the techniques employed are the use of rock rocks and wild grasses at the edges of the terrain and strategic areas to slow down rainwater or plant wild flora on the slopes of mountains and roadsides.

In this case, since the terrain does not have a steep slope and the landscape is flat, it is advisable to do a conservation tillage that consists of disturbing the soil as little as possible, or doing the work less aggressive according to the needs. It presents a series of advantages such as a very good control of erosion, increases the rate of water infiltration in the soil and reduces surface evaporation, preserves and improves soil structure and soil preparation is faster and more timely Reduces costs. On the contrary, a number of disadvantages are low weed control, the organic horizon is shallower, seed bed is worse prepared in some cases and there are more difficulties for the establishment of crops which sometimes results in lower performance.

In addition, it is advisable to keep as many trees as possible, preferably acacias, since they protect the soil from the impact of the torrential rains of July and August, and presents other advantages that are detailed later, in background engineering of the process, where it is established The process of soil fertilization.

On the other hand, the high content of clay has some disadvantages for the mechanization of the soil. These floors have a great plasticity in wet which makes that the wheels of the tractor slides and they are extremely hard in dry what makes that the tractor is stuck and shut up. In addition, the humidity difference to move from one state to another is small so the range of performance is also small. In these latitudes the first rains of the year are torrential reason why the ground goes from being hard to be plastic in a single day, without being the ground in seasoning at any moment. This can be solved by irrigation prior to the May rains. For this, it must be taken into account that a large proportion of the clays are expandable and deep cracks will have formed during the dry months. When the soil begins to absorb water through the surface and through cracks, the clays expand and the cracks close. This can be an advantage when accumulating water in the lower horizons if proper irrigation or a disadvantage is applied if an unplanned soft rain closes the cracks without the soil having accumulated all the possible water in the lower horizons.
In addition to the above, the expandable clays cause problems in the constructions when contracting and expanding, disturbing the foundations of the buildings.

1.6. GEOLOGICAL AND OROGRAPHIC

1.6.1. Geology

Figure 23: Detail of tectonic plates in Horn of Africa. (Source: Google Images)

Ethiopia is located between two tectonic plates, the African plate and the now in Somali plate formation. This geological event that began thousands of years ago will end the total separation of half of Ethiopia, all of Somalia, and part of Kenya and Tanzania. Meanwhile, the process leaves behind unique geological formations in the world, such as the Afar depression, or the Rift Valley. The Afar Depression is studied by many

research groups because of its importance as one of two places on Earth where a mountain range in the middle of the ocean can be studied on land (the other is Iceland).

Geologically, Ethiopia is made up of materials from different geological times. Can be found:

-Materials of the archean eon of the Precambrian, corresponding to the period between 4,000 million years ago 2,800 years ago. Of these, the metamorphic materials, gneiss of the Arero group and the metamorphic granites can be found, especially in the South of the country, and west of the Ethiopian massif.

-Materials of the proterozoic eon, also of the pre-Cambrian, which goes from 2800 million years to about 635 million years ago. They can be found in the north, especially, but also in the south and west to a lesser extent. They stand out the groups Tsaliet and Tambien, composed by .... Y …. Respectively.

-Materials of the Mesozoic era, from the Phanerozoic eon, which goes from 252 million years to 70 million years ago. Of this era are mainly Jurassic and Cretaceous materials in the east of the country, in the Somali region, and in the area of the city of Mekele, in the north, near the Afar region. In the northern zone, materials of the tertiary can also be found.

-Materials of the Cenozoic, also of the phanerozoic, that comprises for 70 million years to the present time. Most of the Ethiopian landscape, the center of the massif, the plateau is made up of materials from the Paleocene, Oligocene and Miocene (from 70 million years ago to 7 million years ago) relatively recent. More recent materials, late Pliocene, Pleistocene and Holocene, found in the west and south of the country, can be found in the savannas that are at a lower altitude than the rest of Ethiopia.

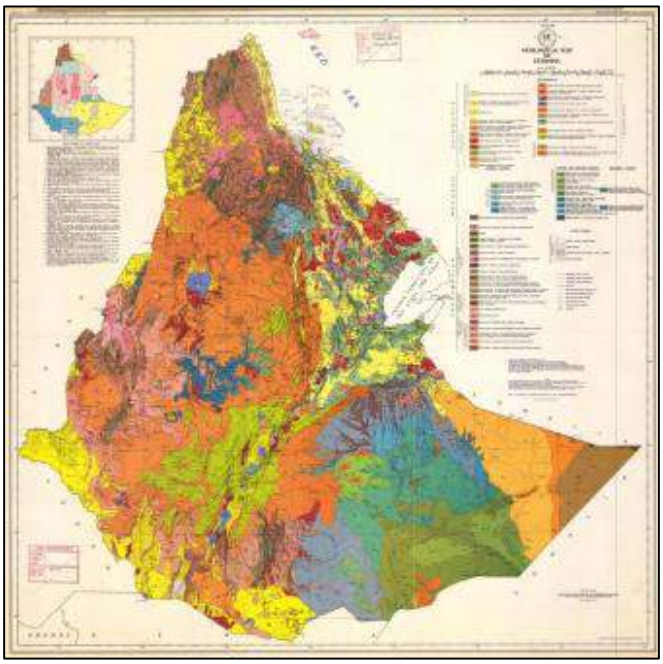


Figure 24: Geological map of Ethiopia. (Source: Google Images)

Gambella is formed mostly by undifferentiated sediments of the Pleistocene, about 2 million years ago, a product of the colluvial material coming from the mountains of the Ethiopian massif, mostly Igneous alkaline basalt rocks of the Cenozoic era. In the eastern part of the region, including the area of the city of Gambella and the land under transformation, there are post-tectonic granite outcrops of the proterozoic era, much older than the previous material.

1.6.2. Orography

The Ethiopian orography is composed of a wide range of forms and heights, ranging from 4553 m above the Rash Dashan summit, to -156 m from the Afar depression. It dominates the mountainous landscape of the great Ethiopian massif that covers the majority of the country. These are two mountain ranges and in the middle the Rift Valley, which crosses the country from east to south-west, concentrating half the mountains of all Africa, some as the Simens mountains (where the top Rash Dashan is located) Including as a World Heritage Site. It is the Ethiopian massif itself that shapes the different agro-ecosystems that exist in the country, among other things thanks to the different heights and the extensive network of rivers and lakes that are formed. The height in the massif varies between 1800 m and 3500 m (not including the peaks), but the country average is 1300 m as some regions such as Afar or Somalia are desert regions that are at much lower altitudes , Even below sea level like the Danakil desert in the Afar region.

Figure 25: Orography of Ethiopia. (Source: Google Images)

Gambella is situated in a little mountainous area, at the foot of the Ethiopian massif, forming a flat or undulating landscape covered by a savanna forest. The region is located at 500 meters above sea level and the highest altitude is only 700 meters above sea level and at least 400 meters above sea level, and therefore the change of scenery from one region to another is abrupt, with an elevation of almost 2000 meters in only 100 km. To each region a flora and fauna easily distinguishable to each other with the naked eye.
This factor is important when planning crop protection for example, since the land is located at the border between the two agro-ecosystems and could be plagues of either (birds, insects, animals and others may fall Of the mountains).

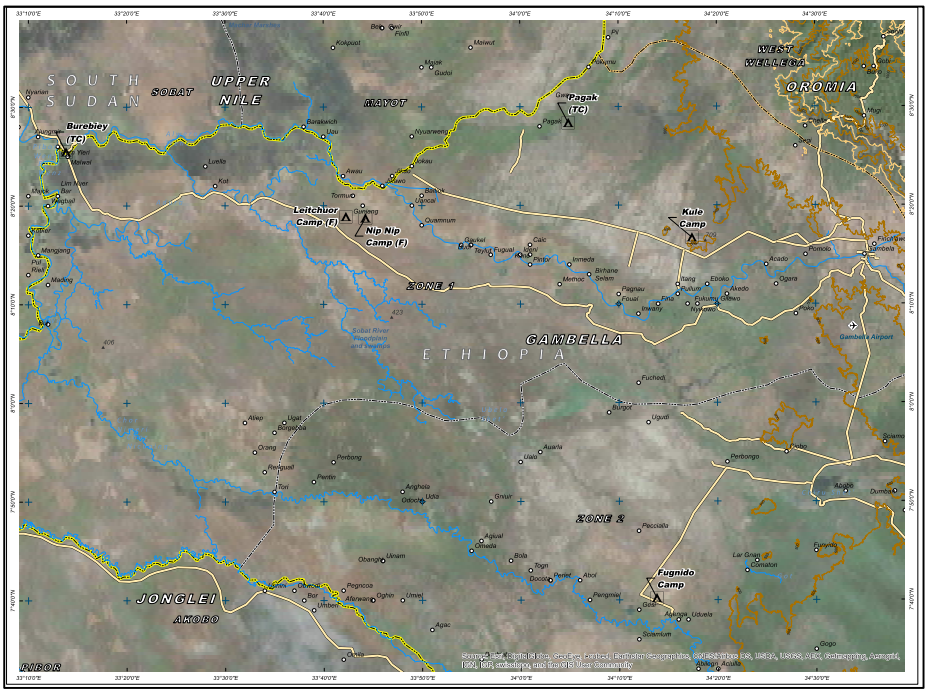


Figure 26: Orography of Gambella. (Source: Google Images)

1.7. SOCIO-ECONOMIC AND POLITICAL

1.7.1. Ethiopia

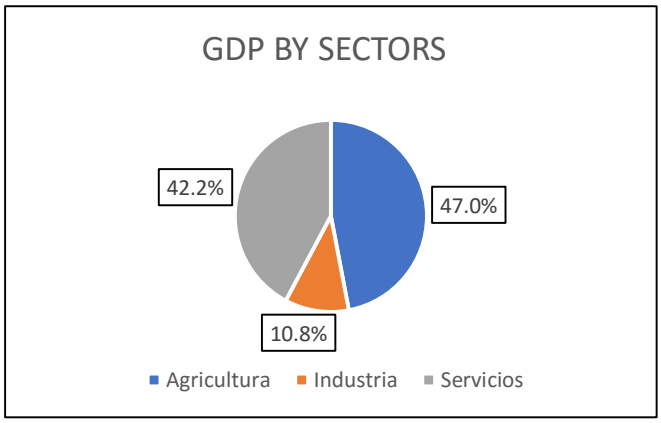
1.7.1.1. Economy

Unlike other countries in Africa, Ethiopia does not have large pockets of oil under its soil, or large gold mines, diamonds, coltan or other minerals that provide its economy with a significant or safe income. The country's GDP (PPA) is 118.2 billion US $, more than 10 times lower than Spanish, for a country with more than double the population (GDP Spain: 1.33 billion). Compared with the surrounding countries, Ethiopia is the 7th African country in terms of GDP (PPP) and the 4th in sub-Saharan Africa. However, being a so populous country, GDP per capita is low, US $ 1300 (US $ 108 per month or US $ 3.55 per day), and in this case the country is ranked 39th in Africa , A place ahead of Eritrea and behind countries like Sierra Leone, Chad or Sudan

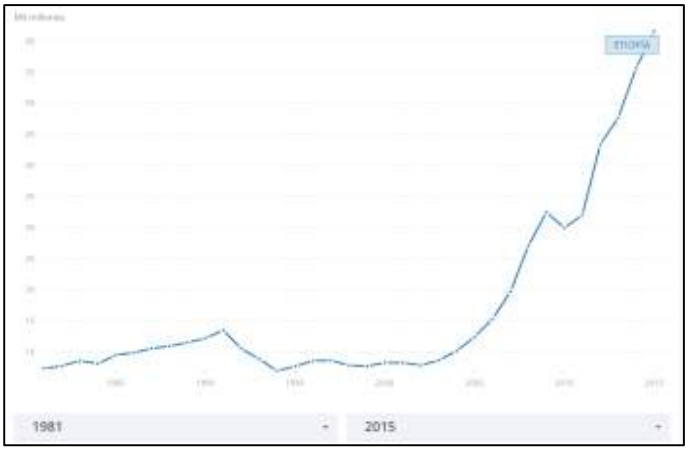
Ethiopia is a mainly rural country, with 47% of GDP coming from this sector. The rest comes from the industry, 10.8%, and from the services sector, 42.2%. It is also reflected in employment, where 85% of the labor force is concentrated in the agricultural sector, a very high figure. In addition, only the production and export of coffee live directly or indirectly around 25% of the inhabitants. The prices of coffee in the international market fluctuate strongly, making this considerable part of the population very vulnerable. The rest of the active population is divided between the industry that employs 5% and the service sector that employs 10%.

The unemployment is high, of 17.5%, leaving to Ethiopia in the position 163 according to the CIA: World Fact Book. However, the annual growth is very high, around 7%, driven by foreign investment, mainly from China that holds almost all of the country's major works contracts, roads, tunnels, tram, oil and others. Inflation is also very high, around 8.4% which in the long run is damaging the purchasing power of Ethiopian families.

Ethiopia tries to take advantage of the large amount of water flowing through its territory to generate electricity. Thanks to the Blue Nile dam, it will be able to general 5000 megawatts of electricity for its own use and also for its neighboring countries, Djibouti and South Sudan especially. Other projects are under way such as in the Gambella region where a dam is planned to be built on the Baro River.



Graphic 7: Distribution of Ethiopian GDP by sector. (Source: FAO Stat)



Graphic 8: Evolution of Ethiopian GDP since 1981. (Source: FAO Stat)

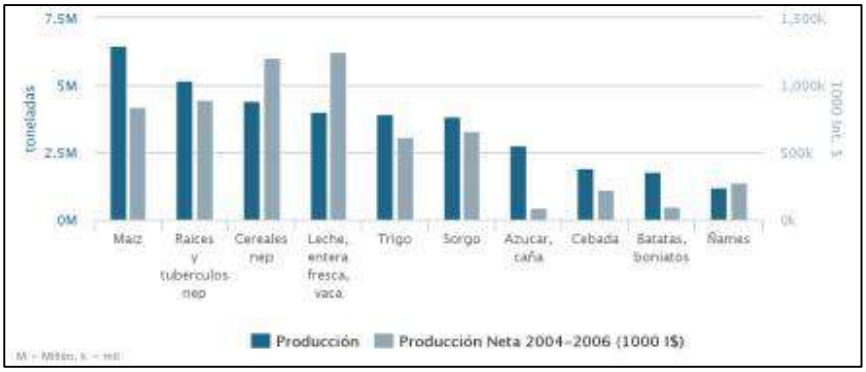
The main customers are China, Germany, the United States, Belgium, Saudi Arabia and mainly export agricultural products, which account for 80% of exports, mainly green coffee, sesame seeds and fresh vegetables. It also exports mechanical appliances, furs and footwear.
The main suppliers are China, the United States, Saudi Arabia and India, and are mainly imported vehicles, electrical appliances and electronics.
The official currency of the country is the Birr and the exchange rate to March 2016 is € 1 = 23.6649 birr.

1.7.1.2. Agricultural sector

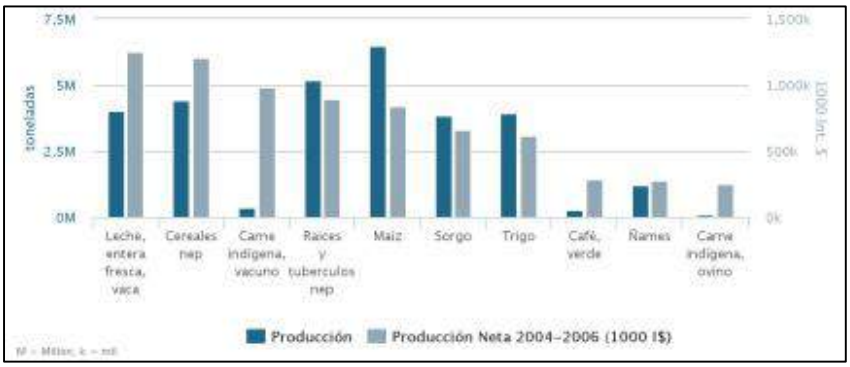
Ethiopian agriculture is constantly threatened by periodic drought, soil degradation caused by overgrazing and deforestation, high levels of taxation and poor infrastructure, making it difficult and expensive to bring products to market. Since the early twentieth century under the rule of King Mekele I and then under Haile Selassie Emperor, he tried to boost the sector, but without great success among other reasons due to poor legislation and underinvestment. 1972-74 very serious drought hit the country hard, and the emperor wanted to hide it from the world so he refused to accept international aid and could not help the affected families, coming to die about 200 000 people. This was

another factor to trigger the Ethiopian Revolution, which brought with it the arrival of the communist government, called Derg. This government nationalized the lands and imposed the policy that was applied at that time in the countries of the Soviet Union. During this period production also fell and the demand of the growing population could not be met. Between 1980 and 1986 Ethiopia suffered the worst food crisis ever remembered. More than 400 000 people died during the period 1982 to 1985, not only because of the famine, but also because of the brutal repression that the government carried out to suppress the protests. The current government has maintained the nationalization of land, but has managed to reverse the decline in production, although still under the threat of droughts, as occurred during 2015, which will have grave consequences until the end of 2017. At present there are more than 10 million people at risk of famine in the Ethiopian regions of Somali and Afar and are making many efforts from international organizations such as FAO or WFP, NGOs and the Ethiopian government to mitigate the effects of which is believed to be The worst drought that this country has experienced.
However, agriculture is the most promising resource. Ethiopia has great potential for self-sufficiency in seeds and for the development of exports of livestock, grains, vegetables and fruits. No less than 4.6 million people need food aid annually. In addition, as mentioned above, the Ethiopian agricultural sector accounts for 47% of GDP and 85% of the supply of employment.

The agricultural area of the country accounts for 33% of the total area, ie 36 325 200 ha, and the forest area is 12 336 600 ha, or 11% of the total area. Below are some data on production, imports and exports of the agricultural sector, sorted by quantities and by total value, all obtained from FAO STAT:



Graphic 9: Agricultural production in Ethiopia ordered according to the quantity produced. (Source: FAO Stat)



Graphic 10: Agricultural production in Ethiopia ordered by money quantity. (Source: FAO Stat)

It can be seen that the most important crop of the country is maize with a production of about 6 million tons, followed by roots / tubers and cereals. Maize and Teff form the basis of food for all the peoples of Ethiopia so it is logical that these crops are the most produced. However, it is dairy products that generate more money, followed by cereals and meat products. It should be noted that the most profitable products are, from more to less profitable, beef, sheep meat and coffee.

Graphic 11: Agricultural imports from Ethiopia ordered according to the quantity imported. (Source: FAO Stat)

Graphic 12: Agrarian imports from Ethiopia ordered by money quantity. (Source: FAO Stat)

As for imports, Ethiopia is a country that demands mainly wheat, which are the largest imports in quantity and value. The following 9 products are imported much less quantity and the top 5 are also the top 5 in value.

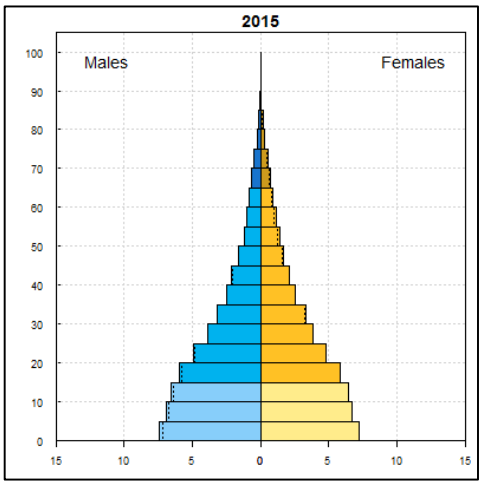
Graphic 13: Ethiopian agricultural exports ordered by quantity exported. (Source: FAO Stat)

Graphic 14: Agricultural exports from Ethiopia ordered by money quantity. (Source: FAO Stat)

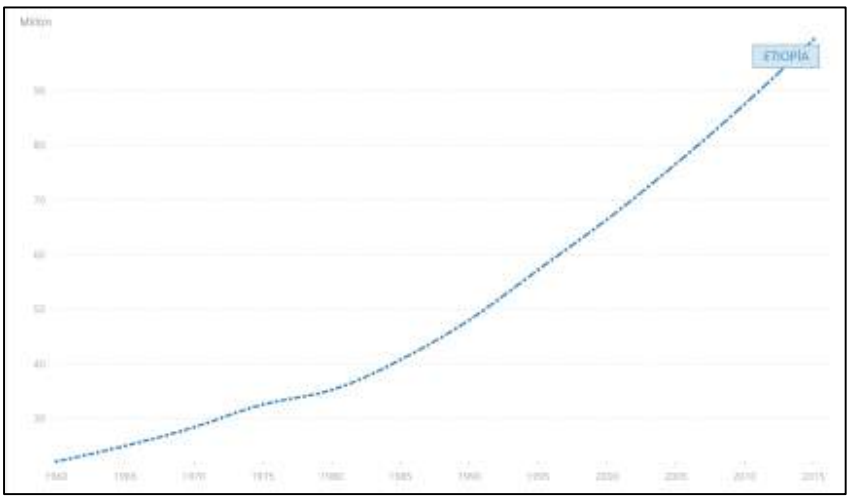
The star exportation is the coffee that is the product that brings the most money to the country, although it is the second most exported after sesame, which contributes half the money to coffee. It also exports beans, chickpeas, wheat and potatoes, but they are fresh vegetables, seventh in terms of quantity, which contributes more money, being in the third place in value. This latter fact is important as it reflects the profitability of fresh vegetables, which has a higher unit value than coffee and sesame, and the potential it has for improving the local economy.

1.7.1.3. Population

Ethiopia is the second most populous country in Africa with 102 million inhabitants ranking 14th in the world, according to the CIA: World Factbook, with an average age of 17 and 63% of the population with less than 25 years. Like its sub-Saharan neighbors it has experienced a high rate of population growth since the 1960s as seen in figure (). More men are born than women, as the male / female ratio is 1.03 at birth, but as the age increases, the ratio falls to 0.99 until age 54, 0.95 from 54 to 64 , And 0.82 more than 65.



Graphic 15: Ethiopian population pyramid in 2015. (Source: World Bank)



Graphic 16: Population growth in Ethiopia since 1960. (Source: World Bank)

Despite of being such a populous country, there are no large cities in Ethiopia such as Cairo or Lagos, since its economy is based on agriculture and the majority of the population lives in rural areas. The capital Addis Ababa has only 4 million inhabitants, and the next largest city, Dire Dawa, has only 430 thousand inhabitants. Other important cities are Adama with 279 thousand inhabitants, Gondar with 209 thousand inhabitants, and Mekele, Dese, Bahir Dar, Jima, Debre Zeyit and Awassa, with between 150 thousand and 200 thousand inhabitants all of them.

In addition, Ethiopia is made up of different nationalities and tribes, as reflected in its constitution. In total there are 83 ethnic groups spread across the 11 regions. The largest group is the Oromo ethnic group, in the region of Oromia, which has about 34 million inhabitants, or 34% of the country's population. The second ethnic group with the largest population is the Amara Ethnicity of the region of the same name, with 26% of the population of Ethiopia. From here the size of the ethnic groups drastically decreases being the following in the list the Somali ethnic group in the region of Somalia with 6.1% of the population of the country, followed closely by the Tigray ethnic group of the Tigray region with 6 %. The rest of the ethnic minorities Afar and Harari do not have a

region of their own and are divided between the regions of Gambella, Benishangul-Gumuz, and the region of the nationalities and towns of the south.

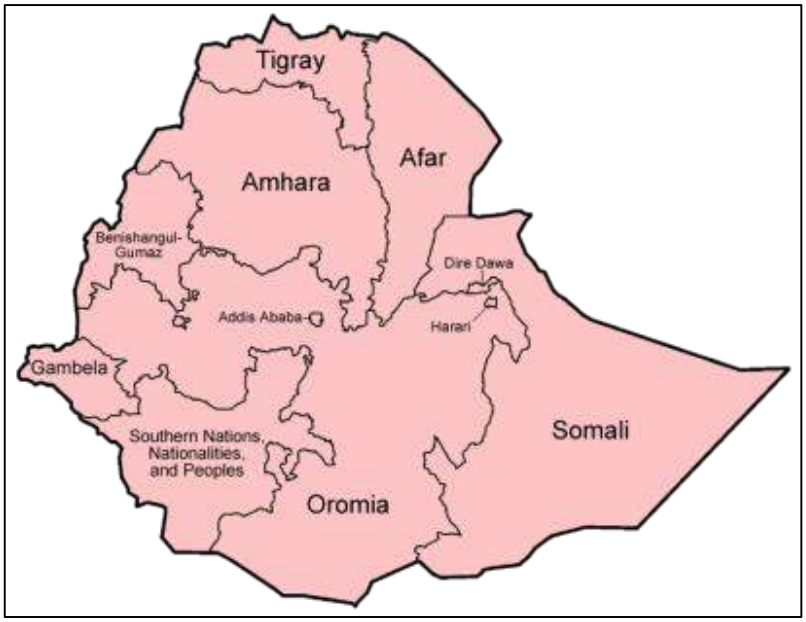


Figure 27: Administrative division of Ethiopia. (Source: Google Images)

Finally, it is worth highlighting the fundamental role that Ethiopia has in the Horn of Africa in relation to refugees, since it is the 5th largest refugee country in the world, behind Turkey, Pakistan, Lebanon and the Islamic Republic of Iran. In total, 736 100 refugees come from the three most conflicting neighboring countries, namely South Sudan, Somalia and Eritrea, and are divided into large camps of up to 100,000 people in the bordering regions of the countries of origin, Gambella , Region of Somalia and Tigray respectively, which are not exactly the most populated.

1.7.1.4. Politics

Ethiopia is a federal democratic republic, with two chambers, the high that represents the federal states, and the lower, whose members (547) are elected by universal suffrage. The lower house elects the prime minister (Haile Mariam Desalegne since 2015, member of the Democratic Revolutionary Front of the People), whose function for 5 years is that of head of state. The president (Dr. Mulatu Teshome Wirtu) has protocolary functions and is elected for six years by indirect suffrage. Since 2005, the Ethiopian People's Revolutionary Democratic Front has seized power, with 556 of the 557 congressional seats accumulating in the fifth election since the fall of the communist regime. Although it is possible to emphasize that it is the ethnic group of Tigray that holds the power from the fall of the Derg in 1991 which is degenerating in serious confrontations with the other ethnic groups, mainly with the Oromo and the Amara.

Multiethnicity is reflected in the constitution with the phrase, "we nations, nationalities and peoples of Ethiopia ...". The territory is divided into 9 states, Afar, Amhara,

Benishangul-Gumuz, Gambella, Harar, Oromia, Southern Peoples and Nations, Somali Region and Tigray, and two autonomous cities Addis Ababa and Dire Dawa have a special status. In turn, each state is divided into Zones, sub-cities and woredas. The project is located in Gambella, in the Anuak area, in the woreda Gambella Zuria.

Ethiopia is a strategic country as it is a stabilizer in the Somali and Sudanese areas, and is a member of the UN, AU (African Union), IGAD (Intergovernmental Authority on African Development East Africa), COMESA (Common Market for Eastern and Southern Africa), ACP (Africa - Caribbean - Pacific, European Union Countries for Lomé IV Conventions, Free Trade Area), and ADB African Development Bank or ADB African Development Bank).

1.7.2. Gambella

1.7.2.1. Economy

Gambella's economy is based on cattle ranching and poor farming, which is rather subsistence agriculture. It does not export any manufactured products, although it is projecting an industrial gin. On the other hand, there is a large presence of multinationals in the area of agriculture first, gold mining second, and in the third oilfield and large number of international organizations such as WFP, UNICEF and UNHCR and NGOs such as Doctors Without Borders and Save the Children, especially to support South Sudanese refugee camps. It can be said that the only inflow of money in the region are the payments of officials and staff of NGOs, international and multinational organizations, aid, investments in agriculture and mining, and the money that migrants send from abroad to your families. But during the last year all the foreigners of the city have been repatriated so the local economy has been seriously affected since hotels bars and restaurants have lost almost half of their customers.

In Gambella, the commercial activities are divided by ethnic groups. Thus the small shops and establishments are all run by "highlanders", especially Oromia, while the posts of the regional state administration are occupied by Nuer in its majority. Livestock is practiced by all groups while agriculture is practiced differently depending on the tribe, again. It is the "highlanders" who practice more advanced agriculture, using pesticides and different species while the Anuak and Nuer grow only maize with very low yields. In addition, of maize, these tribes take advantage of the silvicultural resources like honey, the wood for construction, the fruits and the fish that the rivers provide, to sell them in improvised markets and to improve its economy. Another important resource they derive from forests is coal which is the main energy source in Gambella's homes.

1.7.2.2. Population

According to the Central Statistical Agency of Ethiopia, Gambella's total population was 306,000 in 2007, of which 159,000 were men and 147,000 women. In addition, 25% of the population is urban and the population density was 10 inhabitants per square kilometer. The largest city is Gambella, with 33,000 inhabitants.

Gambella's society is divided into tribes that make up a changing mosaic and difficult to define. There are more than 10 tribes in the region, of which five are Nilotic (branch of the Nile-Saharan languages) and originate from Gambella, the Nuer, the Anuak, the Mezhenger, the Apana and the Komo. There are also other Nilotic tribes but with very little representation and living on horseback between two regions or between Ethiopia and South Sudan, such as the Murle tribe in South Sudan or the Nyangatom tribe in the Southern Nationalities region. All Nilotic cultures are to a greater or lesser extent nomadic and pastoral. On the other hand, there are inhabitants whose ethnic groups do not originate in this region or South Sudan, but they come from other parts of Ethiopia, Afro-Asian speech such as Oromo, Amara, Tigreños and Kambaateños, and omotic speech as the Kafficho And the Shakacho. The latter groups coming from other regions are distinguished from the Nilotic tribes since they have the clearest complexion. In addition, these groups did not go as far as the villagization process that the Derg undertook in the 1980s to blend all the tribes of Ethiopia and create a nationalist sentiment while forcing the nomadic tribes, difficult to control in those Moments. In day-to-day Gambella, for practical purposes, tribes from other regions make up a large group whose members are called Highlanders by the local tribes and who rely on them To each other.

But you have to keep in mind that the borders are not controlled and between South Sudan and Gambella there is a continuous flow of people. Thus, thousands of Sudanese refugees arrive, most of them nuers fleeing the war between the Dinka tribe and the Nuer tribe in South Sudan since 2013. In total there are 214,000 refugees counted, although it is believed that there are many. That means that there are almost as many refugees as inhabitants of Gambella, an extreme situation that rules the life of the region. They are divided into four camps of 50 thousand people and one of 14 thousand. They are very difficult to manage and become improvised cities based on containers of ships, where there is no law or order and where the trafficking of weapons from the neighboring country is a constant concern for the inhabitants of Gambella.

Another important tribe is the Fulani tribe, also called Fula in English, Peul in French, Felata in Nuer and countless other names. This is so since they are the largest nomadic tribe in the world and live between Nigeria and Kenya and therefore have names in all the languages of the countries they go through. To Gambella they arrive between April and May and they cross it along with their cattle to arrive at Kenya where the summer pastures await them. It is not known how many Fulani come to pass through the region since there is no census of the population. In contrast to the constant conflicts between the tribes inhabiting Gambella, the Fulani enjoy the respect of all tribes. During the months of April and May every day hundreds of fulani spend on their Zebu cows, on which they mount their tents. They camp for a few days with their cattle outside the city, where they go only to sell milk and buy basic products or go to the doctor. They come to sell hundreds of liters of milk, contributing to the local economy in a significant way so it is a factor to take into account.

Nilotic tribes do not interact with each other, each has an assigned area in the city and region. However, highlanders can settle in any area and interact with any ethnicity with

which they are not in conflict at that time. The farm is located in the Anuak region, near a refugee camp and the school where the classes are taught is located in the Anuak area of the city.
Below is a table with the list of ethnic groups, their population and language.

Table 25: Populations, tribes and ethnicities of Gambella. (Source: www.csa.gov.et)

ETNIA/TRIBU/GRUPO	POBLACIÓN	% DEL TOTAL	IDIOMA
NUER	134640	44	NILÓTICO
HIGHLANDERS:	74694,6	24,41	
AMHARA	25765,2	8,42	AFRO ASIATICO
OROMO	14779,8	4,83	AFRO ASIATICO
KEFFA	12546	4,1	OMOTICO
MOCHA	6120	2	OMOTICO
KAMBAATA	4406,4	1,44	AFRO ASIATICO
SAKACHO	7038	2,3	OMOTICO
TIGRAY	4039,2	1,32	AFRO ASIATICO
ANUAK	64260	21	NILÓTICO
MEZHENGER	11628	3,8	NILÓTICO
APANA	20777,4	6,79	NILÓTICO
KOMO			NILÓTICO
MURLE			NILÓTICO
OTROS			
TOTAL	**306000**	100	
REFUGIADOS	**214000**		NILÓTICO
TOTAL+REFUGIADOS	**520000**		

1.7.2.3. Politics

Gambella is governed by a president directly elected by the inhabitants of the region. The current president of the Gambella People's Democratic Movement (GPDM), Gatluak Tut Kot of the Nuer ethnic group, has been in the post since 2013. Before 2005 and since 1990, the country's presidents have ruled the country Anuak since they were majority at that time. Gambella's political life is full of ups and downs and is considered one of the most conflictive regions in the country and Africa. Between March and June 2016 the federal government had to intervene in the regional government and put in charge a manager since the Nuer and Anuak tribes had taken advantage of their positions in the administration and in the police corps to attack the ones the others. The resulting conflict in a war between nuer policemen and anuak policemen that had to be stopped by the Ethiopian army. After following a training course for 4 months, July returned to their jobs.

Of all the regions, the territorial division of Gambella is the one that has changed more in the last century. During the Derg the region was divided into four zones called 1, 2, 3 and 4 and a special woreda, Godere. It is currently divided into three zones called with the

names of the three most important local ethnic groups, Nuer Zone, Anuak Zone and Mezhenger zone.

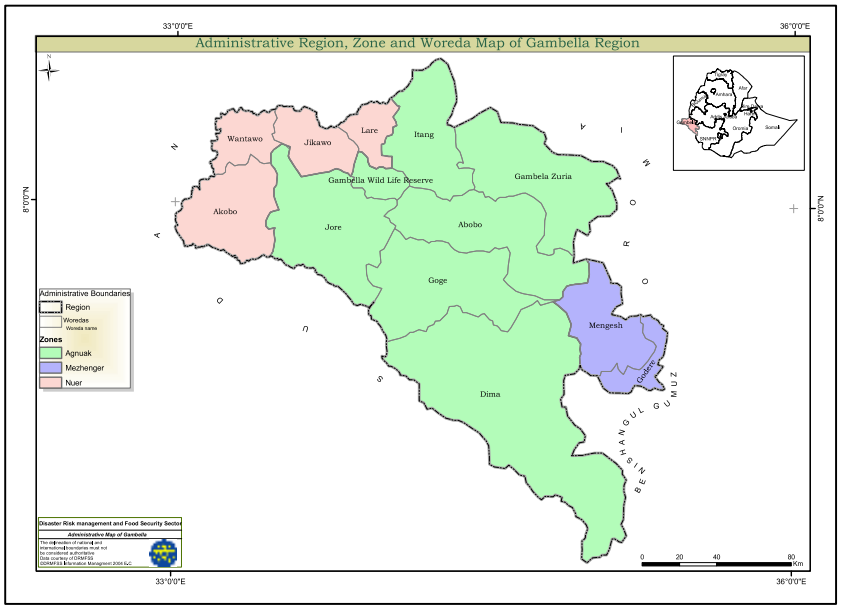


Figure 28: Administrative division of Gambella. (Source: Google Images)

2. PROJECT AGENTS

The project is carried out at the request of the technical school of professional training "Don Bosco Technical School of Gambella" being the promoter and the owner of the lands in question. The contractor who will carry out the project is the engineer graduated in agricultural engineering and science Sebastián Sangro Lucas.

The substantive body (OS) referred to in the project is the Ministry of Agriculture and Natural Resources of Ethiopia (Ministry of Agriculture and Natural Resource) in this case represented by the Department of Agriculture of the Gambella (Agricultural Bureau of Gambella) .
The environmental agency (OA) is the Environmental Protection Authority, in this case represented by the Bureau of Forest Conservation of Gambella (Gambella).

3. CURRENT SITUATION OF THE EXPLOITATION

3.1. Location of transformation

The farm is 60 hectares and is located 12 km south of Gambella, in the region of the same name. The property borders on the east with small plots that directly overlook the Baro River and whose boundaries are not well defined on the land. However, to the south it is bordered by an unpaved road, to the west by the asphalted road from Gambella to the Oromia region, and to the north by other parcels dedicated to the

cultivation of okra, maize, papaya and others and separated by a small tributary Of the Baro.

The exact location is: Sexagesimal grades 8º 10 20.84 North, 34º 39 26.51 West and in decimal degrees 8.172455, 34.657364

Figure 29: Location of Ethiopia in Africa. (Source: Google Maps)

Figure 30: Location of Gambella in Ethiopia. (Source: Google Maps)

Image 3: Location of the plot in Gambella. (Source: Google Earth)

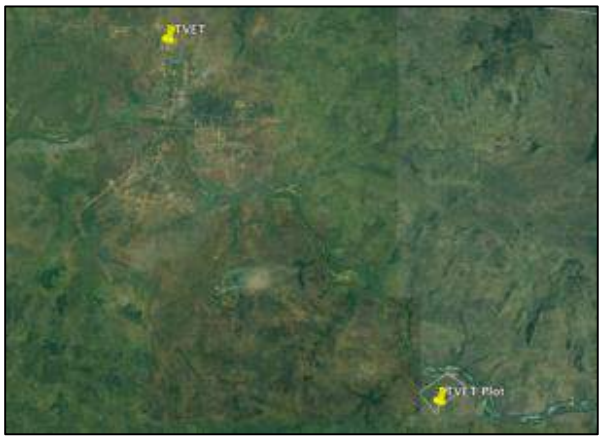


Image 4: Location of the plot in relation to the school. (Source: Google Earth)

Image 5: Aerial view of the plot. (Source: Google Earth)

3.2. Actual state

The farm, with a total of 60 ha, was ceded two years ago by the local government for an indefinite period to carry out the professional training in agriculture. It is a virgin land, with savanna forest that has never been used as an agricultural operation and inhabited by innumerable animal and plant species. Only in the parts near the river, up to a hundred meters from the shore, are settled Anuak communities that cultivate maize (monoculture) in the rainy season. These communities use the forest resources of the farm, including wood, coal, honey, tubers and medicinal and aromatic plants, fruits, game and others.

4. FUTURE SITUATION WITHOUT PROJECT

Without the realization of the project the terrain will remain in disuse and consequently the right of exploitation will be withdrawn by the local government. If that happens the vocational school will not be able to teach the course of agriculture and all the efforts and investments made to date to create it will have been in vain.
On the other hand, the land can continue as this, ie virgin, or be ceded to another organization that carries out a social work in the field of agriculture, or in the worst case, can be rented to a multinational.

ANNEX 2: STRATEGIC ALTERNATIVES STUDY

Sebastián Sangro Lucas

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1. CULTIVATED SPECIES ELECTION

1.2. Species characteristics

-Chard:

Climate: temperate climate will negatively affect sudden changes in temperature. It is best suited to humid temperate climates, withstands frost when the leaves are not yet very large and do not need excessive light, although it grows well in the sun.

Soil: grows best on well - drained clay soils, but with great power of absorption and rich in organic matter.

Management: The leaves are utilized. It is collected around 3 months after sowing, can be done manually. It is attacked by slugs, snails, worms and others.

Local acceptance and market: An unknown product to the market of Gambella and its people.

Specifications: The leaves can be eaten in salads or cooked. It strengthens the immune system, helps prevent eye diseases, intestinal, kidney stones, fluid retention, diabetes, cholesterol, cramps, headache, depression, etc. It is a laxative, digestive and very low caloric plant. In addition, it has a high content in vitamins A and C.

-Garlic:

Hardiness: Tolerant well to cold, and temperatures below 16ºC need to fully develop and that yields are high. Requires lots of sun.

Floors: It needs light and loose soils, little clay, limestone and preferably with little organic matter, but developed in any soil provided it is not too moist and well drained this.

Management: It takes advantage bulb. The segments are used to

multiply the garlic. For harvesting, they are manually removed from the soil and allowed to dry in the sun for 2 or 3 days. At these latitudes, maturity is reached at 4 months, when the leaves begin to dry.

Local acceptance and market: this product is well known and used in Ethiopian cuisine. It is cultivated anecdotally in Gambella and some local tribes do not include it in their diet, for not having the economic means to buy it, or even for not knowing how to cook it.

Specifications: It is considered diuretic, tonic, antiseptic and appetite stimulant. In addition, it has a great bacteriostatic power which confers antibiotic and fungicidal properties. It helps to lower cholesterol. It is also used as an insect repellent.

-Artichoke:

Climate: warm temperate climate plant and not humid frost - free because it does not tolerate frost and cycle covers almost all year. Excessively high temperatures in April and May can stop growth.

Floors: No floor demanding, although it does best in clay-calcareous soils with high water holding capacity and available but well - drained organic matter.

Management: The cultivation time is 8 months from planting to harvest so it is a crop with more risks. The flower of the plant is used and the crops of third or second year are more productive.

Local acceptance and market: are known in the rest of the country, but it is rare that reach Gambella. It is even rarer that they reach the villages so that the local tribes are unknown to them.

Specifications: It has diuretic and antidiabetic properties. It is used as a hepatic protector and prevents dry eyes.

-Celery:

Climate: It is a crop that warm temperate climate that grows well between 15 and 20, although it grows in a wide range.

Soil: grows well in any kind of soil provided you have some water retention capacity available, well drained and rich in organic matter and humus.

Handling stems and leaves are used. The duration of the culture is 4 to 6 months. The crop can be staggered, so that the crop can be used for longer, using the resources more efficiently.

Local acceptance and market: this crop is not known.

Specifications: It aids in digestion. It is attributed diuretic, antibacterial and blood purifying properties.

-Eggplant:

Climate: It requires high temperatures to develop, being severely damaged by low temperatures and frost. It can withstand temperatures of over 40 ° C.

Floors: No withstands waterlogging so it needs well - drained soil or light. On the other hand, it needs lots of organic matter and humus.

Management: staggered harvest for 3 or 4 months when it is not yet ripe for seeds do not grow and embitter the fruit.

Local acceptance and market: Although it is an unknown product for Ethiopians, increasingly grown more for good adaptation to the Ethiopian climates. In Gambella can be found near the border with Oromía, although it is a product totally unknown in the region.

Specifications: It has a low caloric intake, making it suitable for use in diets. Digestive and diuretic properties are attributed to it.

-Boniato:

Climate: Plant warm weather, you need temperatures above 12 ° C, although optimum development is between 15 and 30 ° C to shoot and 24 to 27 ° C for tuber.

Soil: Prefers light soils, soft and well drained. Not very sandy soils or very clayey or with lots of organic matter.

Management: The cultivation time is 4 to 6 months from planting to harvesting. The tubers are left on the ground for a few days to dry.

Local acceptance and market: It is a product known in the Gambella region, it can be found in markets, but is not grown in the villages.

Specifications: It is a raw material of great interest for both human consumption and for animal. They have a high content of carotene, vitamin C and proteins.

-Broccoli:

Climate: temperate climate needs temperatures of 24 ° C environment. They affect the high temperatures, reducing the percentage of germination, and the excessive ones of April and May can kill the plant.

Floors: They need soil with good drainage and water holding capacity. If it is a late variety, clay soils are preferable, and if it is an early variety, sandy soils are preferable.

Management: The crop requires 5 to 6 months to develop and be collected. Harvesting is done when the flower is closed and has a bright green appearance.

Local acceptance and market: This product is not known in Gambella, but can be found in some regions. Local tribes do not

include it in their diet.

Specifications: It is very nutritious, contains vitamins A, B $_{2,}$ C and is low in calories. It is attributed antioxidant, detoxifying and anti-infectious properties. In addition, it is considered good for heart disease, osteoporosis, anemia, constipation and hyperthyroidism.

-Peanut:

Climate: warm weather plant withstands high temperatures.

Floors: Need soils high in nutrients, organic matter and well drained overstuffed.

Management: It is a legume so it is nitrogen fixer. The duration of the cycle is about 4 months. When the pod is forming underground, the soil should not be moist as it may rot.

Local acceptance and market: It is a well - known product and all tribes consumed daily in Gambella and other regions. In Gambella not cultivated too much, being difficult to find grounds with this culture, but not crazy.

Specifications: Peanuts are an important source of vegetable oil. They are highly nutritious, rich in protein, fiber, phosphorus, magnesium, calcium, vitamin E and very easy to digest. They are attributed beneficial properties to combat liver colic, nephritic and intestinal inflammation.

-Zucchini:

Climate: Plant warm weather, you need temperatures above 15 ° C to germinate. It resists the high temperatures well and has great needs of light and humidity.

Soil: prefers medium soil, well drained texture, rich in organic matter and well drained.

Management: The cultivation time is 4 months until harvest which is done when the fruit is about 15 cm in length, and is done in stages. You can also consume the cooked flower.

Local acceptance and market: not in the local market, although in certain parts of the country. The local tribes do not know it.

Specifications: It is low in calories. It is attributed diuretic properties.

-Pumpkin:

Climate: warm temperate climate plant has high demands heat and sun exposure.

Soil: tolerates any soil, but prefers those loose and fluffy, with lots of organic and able to retain water during times of very hot matter.

Management: The cultivation time is 3 to 5 months from planting to harvesting which takes place when the fruits change color and the skin hardens. You should leave 4 to 6 fruits per plant, or up to 2 if you want bigger. They can be kept for a long time thanks to their thick skin.

Local acceptance and market: This product is known in the country and the region. It can be found in the local market but is not grown in the region and local tribes do not use it in their kitchens. Cooked flower can also be consumed.

Specifications: It has laxative and diuretic properties. Seeds have antiparasitic properties.

-Thistle:

Climate: Typical of temperate climates and autumn-winter development.

Soil: Prefers deep soils, rich in organic matter and light.

Management: Harvesting is done in stages, starting between 4 and 6 months after planting.

Local market acceptance and unknown to the Ethiopians and the region of Gambella Product.

Specifications: It is considered a vegetable and digestive tonic. It is attributed medicinal properties, it is purifying, good for the liver, osteoporosis and diabetes.

-Casava:

Climate: It is a plant adapted to inter - tropical climates so it does not support low temperatures. On the contrary, it needs a lot of humidity, heat and exposure to the sun for its good development.

Floor: Depending on the variety, it adapts to any soil, but prefers deep, rich, soft and well drained with good water holding capacity, but without the risk of flooding.

Management: The cultivation time is between 9 and 18 months so you can put on the market at the right time. The product should be treated within 48 hours after collection for storage.

Local acceptance and market: An unknown product in Ethiopia and Gambella.

Specifications: It has high starch content, but also a significant content of cyanogenic glucosides, and free cyanide, which can affect digestion thereof.

-Onion:

Climate: temperate climate plant that resists cold but requires high temperatures and prolonged exposure to sun bulb formation.

Soil: they prefer light, loose soils, or at least well cushy and well

drained as excess moisture leads to problems root rot.

Management: The cultivation time is 6 to 8 months. Before forming the flower you can bend the stem to avoid it and thus concentrate the efforts of the plant in the bulb. It is harvested when the outer leaves are dry and allowed to dry on the ground for a few days. They are stored hanging in a dry and ventilated place.

Local acceptance and market: It is a widely known and used in Ethiopia and Gambella region product. Some lands cultivate it in the region, although anecdotally. The local tribes know and consume it.

Specifications: It tonic, diuretic, it protects infections, regulates the digestive system and is equipped with anti - rheumatic properties. It is attributed an important role in the decrease of cholesterol accumulation and in the prevention of coronary diseases. It is low energetic and very rich in mineral salts, vitamins A and C.

-Chufa:

Climate: summer crops in temperate zones development, therefore resists high temperatures, although the optimal temperature is between 13 and 25 ° C and high humidity favor.

Soil: Prefers sandy loam soils, since in heavier soils are deformed tubers acquiring an elongated shape. It needs good drainage and abundant organic matter.

Management: The cultivation time is about 4 or 5 months. Before harvesting, the aerial part of the plant is cut and collected manually with the help of a tool such as a collection hopper.

Local market acceptance: Unknown in Ethiopia.

Specifications: It contains many unsaturated fatty acids, especially linoleic acid, vitamin H and vitamin P, which protect the blood

vessels. In addition, it contains more than 25% fat, 30% starch, more than 7% protein and many minerals (calcium, magnesium, potassium and sodium). They are classified as an integral product very rich in fiber.

- Cauliflower:

Climate: It is a temperate climate plant that grows best with mild temperatures and humid environments.

Floor: They are very demanding in nutrients, and low tolerance to waterlogging and therefore require well - drained soil or light and fluffy and very organic matter.

Operation: Depending on the variety, cultivation duration can range from 3 to 6 months from planting to harvest. For the flower to remain white, it should be covered with the nearest leaves to avoid direct exposure. Harvesting is done when the flower has reached its maximum size, but has not yet been opened.

Local acceptance and market: It is known in other regions of Ethiopia. Local tribes do not include it in their diet.

Specifications: They are low calorie, rich in vitamins (B_1, B_2, B_3, B_5, B_6 and folic acid) and minerals (potassium and phosphorus). They are attributed antioxidant and diuretic properties. In addition, they are considered good for the nervous system and bones.

-Endivia:

Climate: temperate climate plant winter cold autumn development that resists frost, with optimum growth temperature of 16 to 20C.

Soil: The ideal soil is a medium or light, deep, well - aerated and moderate levels of soil organic matter and nutrients.

Management: The cultivation time is 3 to 5 months, and harvesting is done in stages.

Local market acceptance and unknown Product in Ethiopia.

Specifications: It is rich in minerals. It is attributed to medicinal, tonic and depurative properties: it improves circulation, prevents atherosclerosis and regulates intestinal transit.

-Endive:

Climate: warm temperate climate, resists bad cold temperatures and moderately well high.

Floor: Fits best in soils means, slightly clayey, loose and fluffy with good water holding capacity.

Management: The collection begins 3 months after planting. It is staggered, cutting the whole crown so that the plant sprouts again or cut individual leaves.

Local market acceptance and unknown product in most of the country.

Specifications: Contains especially vitamin C, in addition to A, B_1 and B_2. It is rich in fiber and is credited with depurative, diuretic and stimulant properties of liver function.

-Spinach:

Climate: It 's a cool temperate climate plant that does not withstand excessive heat while if excessive cold.

Soil: Adapts well to soils on average, slightly sandy, deep, rich in organic matter and moist consistency, but with good drainage.

Management: The cultivation time is 2 months until the harvest, which is done in stages. The leaves are cut when they are large enough and fleshy or the whole plant is cut when it is in optimal conditions.

Local acceptance and market: It is a product used in traditional Ethiopian cuisine in many dishes. In Gambella, local tribes know it and include it in their diet.

Specifications: It has a high water content, vitamins and minerals. They are considered good for the digestive system and for the prevention of osteoporosis.

-Chickpeas:

Climate: rustic plant that resists well under a wide range of climatic conditions depending on the variety, though noted for its drought resistance.

Soil: Prefers well - drained soils clayey silt and soft as it needs good aeration and supports bad the flooding, but needs moisture. It is a legume for which it is fixing nitrogen.

Management: Harvesting is done 6 months after planting in temperate climates. The aerial part is cut and stacked letting it dry a few days before threshing. The dry chickpea is well preserved in a dry place with no light.

Local acceptance and market: It is a product widely known in Ethiopia and Gambella where it is consumed in various ways. It is used dry and crushed as a seasoning and for the elaboration of typical pastas and dishes.

Specifications: Legumes are as rich in protein as meat and almost as rich in carbohydrates such as cereals. Together with these, they are the foods with lower content in water and the rich ones in fiber, constituting a very valuable food from the nutritional point of view.

-Pea:

Climate: humid temperate climate plant. It can not withstand temperatures above 30ºC, seriously damaging the fruit.

Soil: Prefers sandy soils, loose, well - drained and aerated texture, organic matter content without excessive limestone. It fixes nitrogen in the soil.

Management: The cultivation time is 2 to 3 months and the harvesting is done in stages once have swelled the pods. These are cut by holding the stem by hand so as not to damage it and affect the following fruits. When the temperature is high care must be taken that the grains do not dry and harden.

Local acceptance and Art Market is a product known in Ethiopia and Gambella where you can find in the local market.

Specifications: It has a high content of minerals, fiber and sugars. It improves circulation and intestinal transit, controls sugar levels, prevents osteoporosis and anemia, protects the nervous system and improves mood.

-Bean:

Climate: It is a temperate plant that resists very low temperatures. They damage the excess heat because they are typically autumn or winter development, in fact, the seeds do not germinate above 20ºC. In addition, it is sensitive to drought.

Soil: Preferably loamy, slightly clayey, fresh and with good water retention, but well drained. It fixes nitrogen in the soil so the following crops can benefit and less nitrogen fertilizer is required.

Management: Harvesting is done in stages, from 3 months after planting, when the pods are sufficiently developed, but still green and before the seeds skin begins to become rough.

Local acceptance and market: It is a product known in Ethiopia, which is used in some dishes. In Gambella is not cultivated, but can be found in the local market.

Specifications: It is a very nutritious and rich in protein spring crop par excellence. It is attributed diuretic, depurative and antirheumatic properties.

-Lemon grass:

Climate: It is a Poaceae adapted to tropical climates and resistant to high temperatures, and quite resistant to drought.

Soil: Adapts well to any type of soil, but prefers those means or slightly clayey, soft, with good water retention capacity and lots of organic matter.

Management: The culture duration is 4 months until harvest time. You can cut the whole plant but the most common is to cut the leaves and leave the plant to continue producing several years.

Local acceptance and market: It is an unknown plant in Ethiopia, however, being so well - known in the rest of Africa, is grown on several farms in Gambella exploited by foreigners.

Specifications: It is a plant with digestive and relaxing properties. In addition, it is used as an insect repellent, and provides vitamins and minerals.

-Ginger:

Climate: A tropical crop that needs large amounts of water, above 2000mm, but spread throughout the vegetative cycle. In addition, it needs temperatures in excess of 30ºC for two thirds of the year, although direct exposure does not suit you.

Floor: Not a demanding crop soils, although it grows best on well - drained and aerated and rich in organic matter , sandy soils.

Management: The cultivation time is 9 to 10 months after planting. The harvest is done when the aerial part is dried, and before the root becomes fibrous and hard.

Local acceptance and market: It is a product known in Ethiopia where it is consumed in different dishes and teas. In Gambella is in the market with ease, but not cultivated.

Specifications: It has carminative, stimulant and flavoring properties. Crushed ginger is also a component of pickles that Americans call "whole mixed pickling spice."

-Green beans:

Climate: warm weather plant sensitive to cold and high temperatures above 30 ° C. High temperatures and low humidity can lead to the fall of the flower or even the newly formed pod. On the other hand, abrupt changes in temperature cause twisted fruits.

Soil: Prefers a medium or light soil, loamy, well drained and rich in organic matter. It is a legume so it fixes nitrogen.

Handling is harvested in stages, two months after planting, when the sheath has reached a size of about 15 cm.

Local acceptance and market: Known in some parts of Ethiopia, in Gambella can be found at certain times of the year in small quantities.

Specifications: Are attributed antioxidant and diuretic properties. They are rich in fiber, vitamins and proteins.

-Lettuce:

Climate: Plant adapted very diverse climates, although it grows best in warm, humid areas. Excessive heat causes a premature rise of the flower and a bitter taste in the leaves.

Soil: loamy soils are preferred, with lots of organic, fresh material without excessive moisture.

Management: The harvest is staggered from 80 days after

planting. The whole lettuce is cut when it is at its maximum development, but before the flower rises. It can also be harvested by cutting the outer leaves of the buds. They are not kept for long so they should be consumed quickly.

Local acceptance and market: Lettuce is known throughout the country, and in Gambella can be found easily on the market. In some farms is cultivated anecdotally.

Specifications: beneficial properties are attributed as an analgesic, eye drops and deodorant. It is considered as a plant with tranquilizing properties.

-Cantaloupe:

Climate: very demanding in terms of temperature and it needs much heat and sun exposure throughout the growing season climate. They are also suitable for environments that are not wet or even humid.

Soil: Prefers a deep, fluffy, and very organic matter soil.

Management: Harvesting is done between 3 to 4 months after planting. It should be done when the fruit is ripe because once collected does not accumulate sugars.

Local acceptance and market: The melon is known and occurs in Ethiopia, but in small quantities. In Gambella can be found depending on the time of production, but in small quantities, and is not grown in the region.

Specifications: It has a high content of vitamin A. It is considered a food with cleansing, antioxidants and rehydrating properties.

-Turnip:

Climate: Best suited to cold climates. It requires cool, moist conditions, and excessive heat adversely affects it.

Soil: Prefers a medium or light, with good water retention, but well drained, and lots of organic matter.

Management: The harvest is done in stages at 2 or 3 months after sowing. The entire plant is removed from the soil and is usually buried in sand in a cool place to preserve them.

Local acceptance and market: turnip is known in some parts of Ethiopia, but not in Gambella. However, other tubers that grow on the savannahs very similar to the turnip are consumed.

Specifications: It has a high content of fiber, vitamin C and mineral salts. It is considered a good restorative for cases of anemia or osteoarthritis. In addition, they are attributed beneficial properties against constipation. The syrup obtained through its cooking is considered useful to combat respiratory problems and bronchial conditions.

-Yam:

Climate: These are plants from tropical climates that easily tolerate high temperatures, and requires about 1300 mm of water to develop. In addition, they are grown from sea level to 800msnm, and need to be in full sun.

Soil: Requires sandy loam soils being damaged by too clayey soils if they are not sufficiently soft, airy and well drained. In addition, it prefers deep soils and with much organic matter.

Management: The crop cycle is 7 to 12 months. The time to harvest the yam is when the aerial part of the plant withers.

Local acceptance and market: An unknown product in Ethiopia.

Specifications: For its nutritional quality and its contribution in carbohydrates and B vitamins, is used mainly in diets for tiredness, fatigue, depression and nervousness or stress.

-Okra:

Climate: tropical plant and intertropical climate, you need a certain temperature contrast between day and night. It does not tolerate drought, although it must be exposed to the sun. It can withstand very high temperatures, above 38ºC, but it needs a lot of humidity.

Soil: Prefers well - drained, but with good water retention capacity and rich in organic matter, especially potassium sandy loam soils.

Management: The cultivation time is about 4 months after planting, although most commercial varieties can reach maturity at 60 days when grown in the tropics. The crop should be protected with gloves and long clothing since the plant has hairs that cause hives difficult work.

Local acceptance and market: It is a known product and cultivated in Ethiopia. In Gambella it is cultivated for commercialization in some farms of no more than 2 hectares.

Specifications: It is an intestinal regulator, helps against gastritis, and increases cardiovascular health, also contains vitamin C, vitamin E, polyphenols, carotenoids and potent antioxidants. It is recommended for people with hypertension and atherosclerosis, or with stomach problems.

-Cucumber:

Climate: warm temperate climate, need long direct sun exposure. The optimum temperature of growth is between 18 and 28ºC and it does not withstand the cold or the excess of humidity since it favors the development of fungal diseases.

Soil: It is a crop that is well suited to all types of soils, from sandy to very clayey something while you do not puddle, that is to say are

well overstuffed and drain well. In addition, it is best developed in soils rich in fresh and aerated organic matter.

Management: The cultivation time is 3 to 4 months. It is a creeping plant and the fruits are directly resting on the ground. To collect them, they should be cut when they are at their maximum development, but before they yellow, since the plant stops producing flowers and therefore more fruits.

Local acceptance and market: This product is known in Ethiopia and is grown in certain areas. In addition, it is an ingredient used in several typical dishes. In Gambella can be found in the market depending on the time, but is cultivated anecdotally.

Specifications: It is a low - calorie food. It has a high content of ascorbic acid and is rich in calcium, chlorine, potassium and iron. It is attributed diuretic and beneficial properties for the care of the skin.

-Peppers:

Climate: It is a plant of warm temperate climate very demanding in brightness. It resists very high temperatures, but above 35ºC can drop of the flower or the fruit, more so if it is added to a low humidity.

Soil: Requires deep soil, well drained and aerated, rich in organic matter.

Management: The cultivation time is 4 to 5 months and is harvested by cutting the fruit of the plant and storing them in a cool, dry place as it is a perishable product.

Local acceptance and market: several varieties of hot peppers (chillies or chillies) is known but not other varieties for salad or cooking are known. In Gambella is in the market and in some fields are cultivated hot peppers, but anecdotally.

Specifications: It is high in calcium and vitamins A and C. They attributed medicinal, digestive, diuretic, antioxidant, detoxification, antidiarrheal, analgesic and healing. Some varieties of pepper are used as ornamental plants, mainly because of the attractiveness of their small fruits.

-Pineapple:

Climate: It is a plant of tropical climate that develops between 100 and 600msnm. It resists well high temperatures, although its optimum range is of 20 to 30ºC. It needs a humid environment and a high annual humidity regime distributed throughout the year.

Soil: The pineapple has a delicate roots thus requiring soil means, not necessarily deep, but well drained and with lots of organic matter.

Management: The harvest is done when the fruit starts to change color from green to yellow. Depending on the variety this can occur at 2 or 3 years. It must be picked ripe because it is a non-climacteric fruit.

Local acceptance and market: It is a known product and cultivated in Ethiopia. In Gambella can be found in the local market depending on the time, but not cultivated.

Specifications: It is the only plant with bromelain, a molecule that aids digestion and is anti - inflammatory. In addition, it provides many vitamins and minerals, is diuretic, antioxidant, and is recommended for rehydration.

-Leek:

Climate: plant that develops in any environmental condition, but preferably in warm, humid areas. Its optimum growth temperature is 13 to 24 ° C.

Floor: It also adapts well to any soil, but preferably a deep,

fluffy, fresh and abundant organic matter soil.

Management: The cultivation time is 5 to 6 months and the harvesting is done in stages. It should be stored in a cool, dry place.

Local acceptance and market: are known in Ethiopia and grown in some areas. In Gambella they can be found depending on the time of year, but local tribes do not consume it .

Specifications: It has a high content of mineral salts and is credited with a high purifying power of the blood. It is widely used in diets.

-Radish:

Climate: Plant cool temperate climate, adversely affect him high temperatures, giving a spicy radish flavor, but does not affect its nutrient capacity. Also direct sunlight can damage the plant.

Soil: It is preferable to rich media or clay, organic soil, fluffy and deep subject.

Management: The cultivation time is 2 months, and must be collected before they mature and begin to crack radishes. The collection is easily done if the ground is wet.

Local acceptance and market: unknown Product in Ethiopia.

Specifications: They contain vitamins and are rich in phosphorus and potassium. It is a vegetable which are attributed diuretic properties, in addition to antiescorbúticas properties (prevent scurvy, a disease caused by a shortage or absence of certain vitamin feeding principles).

-Beet:

Climate: plant prefers temperate mild temperatures and humid environments, although it is well suited to other conditions. You agree long sun exposure, but will negatively affect long periods of drought and increasing stringiness beet.

Soil: Prefers light, deep, loose, homogeneous and rich in organic matter soils.

Management: The cultivation time is 3 to 4 months after planting, and harvesting is done when the root is about 5 cm in diameter. To maintain quality of the tuber should not leave it too long on the ground once ripe. Round varieties are easier to start from ground that the oblong varieties for which it is necessary to raise the floor.

Local acceptance and market: the product in Ethiopia is known and is an ingredient used in traditional cooking. In Gambella can be found in the market all year, and is consumed by local tribes, but not cultivated.

Specifications: contain a red dye (betacyanin) used in yoghurts and sauces ketchup, among others. They are rich in minerals, have a high sugar content and vitamins A, B and C.

-Cabbage:

Climate: It adapts well to different climates, but generally prefer humid environments because it is sensitive to drought. Depending on the variety, it can withstand high temperatures up to 38 ° C.

Soil: It is a crop that is well suited to many soils, but prefers those of average or loamy, soft texture, with lots of organic matter.

Management: The cultivation time is 3 to 5 months depending on the variety. Harvesting is done when the cabbage is still tight and before cracking.

Local acceptance and market: It is a vegetable used in several Ethiopian dishes, and is grown in several regions of the country. In Gambella it consumed and cultivated anecdotally in some areas.

Specifications: They have a caloric intake low, but high in vitamins A and C, folic acid and antioxidants. They are recommended for digestive system disorders, infections and ulcers. It has diuretic and relaxing properties.

-Watermelon:

Climate: It is a plant of warm temperate climate, which like other cucurbits, requires minimal sun exposure. It resists high temperatures and drought somewhat, but the optimum temperature is between 20 and 30 ° C.

Soil: It is preferable, deep, medium soil with good water retention capacity and good amount of organic matter.

Management: The fruits are mature at 3 or 4 months after planting. The characteristic sound emitted when struck indicates the state of maturity.

Local acceptance and market: This fruit is known in Ethiopia, and is cultivated in some areas. In Gambella can be found in the market depending on the time of year. The seeds can also be eaten.

Specifications: It has a high water content, is slightly laxative and purgative properties are attributed.

-Taro:

Climate: It is a crop of tropical climate that resists high temperatures but needs high humidity and water.

Soil: Prefers soft soil loose and well drained so that they are well means, but they retain much moisture and good amount of organic matter.

Management: The cultivation time is 5 to 15 months depending on the variety and cropping system. Soil tubers are started and allowed to dry a few days.

Local acceptance and market: is a product commercially unknown in Ethiopia. In Gambella it is not found on the market, but local tribes get very similar tubers Savannah, probably the same gender.

Specifications: It is an energy food, high in starch. It also contains dietary fiber, protein, vitamins (A, C, E, B6), folic acid and minerals (magnesium, iron, zinc, phosphorus, potassium, manganese and copper).

-Tomato:

Climate: Plant warm climates, needs at least 6 hours of sun exposure and very hot.

Soil: Adapts well to any type of soil but prefers loamy, deep, loose and soft and rich in organic matter soils.

Handling should perform the staking of plants by rods, nets, or other timber for the plant to grow upright. The cultivation time is 4 to 5 months and the harvest is done harvesting the fruits staggered over several months.

Local acceptance and market: Tomato is a widely known and used in Ethiopian cuisine ingredient. In Gambella you can be easily found on the market for most of the year but not cultivated.

Specifications: Its high vitamin content makes it a fundamental and widely used in food vegetable. Has a high content

of vitamins (mostly vitamin C), antioxidants and potassium. They attributed beneficial properties related to the prevention of cardiovascular disease.

-Carrot:

Climate: It is a plant that prefers temperate climates and does not require high temperatures.

Floor: It is preferable sandy soil, but with good water holding capacity, as soil compaction and stones adversely affect root production.

Management: The cultivation time is 4 to 5 months and the harvest is done by hand with the help of a shovel.

Local acceptance and market: The carrot is known in Ethiopia and is an ingredient used in some traditional dishes. In Gambella they can be found easily on the market, but not grown.

Specifications: They are refreshing, diuretic and antioxidants. Widely used in the food industry for the preparation of frozen, preserves, purees, baby food, food coloring extraction and juices. They are very rich in minerals (fiber, copper, zinc and iodine) and vitamins (A, B and C). They also have a great antioxidant value.

1.2. Election of Species

Of the above species will be a list where they will be ranked better adapted to worse adapted, taking into account the weather, the soil of the land, the local market, the habits of local tribes, the nutritional benefits it provides and other data as easily transport, marketing and conservation.

A value to each criterion is given, 0 to 5 such that:

[1] Climate Adaptation: 0 = No adapted in any way, 1 = not well

suited, 2.5 = fits moderately, 4 = well suited, 5 = particularly suitable for this climate.

[2] Adaptation to soil: 0 = No adapted in any way, 1 = not well suited, 2.5 = fits moderately, 4 = well suited, 5 = particularly suitable for this soil.

[3] Adaptation management: 0 = No resources needed to grow this plant, 2.5 = resources exist, but are not ideal; 5 = have the necessary resources and ideal for growing this plant.

[4] social and market acceptance: 0 = this crop is not known anywhere in the country and it is impossible to introduce by social, religious or other reasons, 1 = not this crop is known anywhere in the country but it is possible to introduce 2 = this crop is known in some parts of the country but not in Gambella, 3 = this crop is known throughout the country and in Gambella can be found in the market based on the time of year, 4 = it is known throughout the country and is an ingredient in traditional cooking or is in the market of Gambella throughout the year; 5 = is known throughout the country and also grown in Gambella, even anecdotally or in the market all year and is an ingredient in traditional cooking.

[5] Nutrition: 1 = contains especially energy, or minerals or vitamins or proteins or other beneficial components, 2 = contains much of two of the above components, 3 = contains much of three of the above components, 4 = contains 4 of the above components, 5 = 5 contains much of the above components.

[6] Property Condition: Kept 1 = very bad, 3 = moderately conserved 5 = very well preserved.

[7] Crop duration: 1 = more than a year, 3 = more than 6 months and less than one year; 5 = less than 6 months.

In addition, each criterion is weighted according to the influence they have on good crop development and improving the quality of life of the people involved.

The criteria [1] and [7] have a coefficient of 1 as they are essential for the proper development of the crop and for people who consume or sold or cycle is very long which increases the chances of something going wrong.

The criteria [2], [4] and [6] have a coefficient of 0.75 since, although not fully fit, are factors that can be overcome.

The criteria [3] and [5] have a coefficient of 0.5 as they are criteria that do not affect or no production, marketing and social acceptance.

Unfortunately no data production for most crops in Gambella as it or not cultivated or data collection is inefficient. However, it is expected that yields are very low since the average maize production in medium-sized farms is about 1000-1600 kg per hectare, which is below the national average.

Here you can see the table where each crop is analyzed and ordered from best to worst total score for each characteristic values unweighted and weighted total shown.

Table 1: Ranking of species for the project. (Own elaboration)

Scientific name	Crop / Feature	[1]	[2]	[3]	[4]	[5]	[6]	[7]	Total	Note of 10
	(coefficient)	1	0.75	0.5	0.75	0.5	0.75	1		
Arachis hypogaea L .	Peanut	5	4	5	5	5	5	5	25.5	9.7
Cicer arietinum L .	Chickpeas	5	5	5	4	5	5	5	25.5	9.7
Ipomoea batatas Lam .	Sweet potato	5	4	5	4	4	5	5	24,25	9.2
Cucumis melo L .	Melon	5	5	5	3	3	5	5	23,75	9.0
Brassica oleracea L .	Cabbage	5	5	5	5	3	3	5	23,75	9.0
Cucurbita maxima Duchesne	Pumpkin	5	4	5	4	2	5	5	23,25	8.9
Okra L .	Okra	5	5	5	5	3	1	5	22,25	8.5
Citrullus lanatus Thumb .	Watermelon	5	5	5	3	3	3	5	22,25	8.5
Cymbopogon citratus (DC .) Stapf	Limon grass	5	5	5	1	3	5	5	22,25	8.5
Allium cepa L .	Onion	4	4	5	5	3	5	3	21.5	8.2
Lycopersicon esculentum Mill .	Tomato	5	5	3	4	4	1	5	21	8.0
Vicia faba L.	Bean	1	4	5	4	5	5	5	20,75	7.9
Zingiber officinale Rosc.	Ginger	5	2.5	5	4	3	5	3	20,625	7.9
Beta vulgaris L . *var. conditiva* Alef .	Beet	2.5	2.5	5	4	4	5	5	20,625	7.9
Capsicum annuum L .	Peppers	4	4	5	5	3	1	5	20.5	7.8
Colocasia esculenta (L .) Schott	Taro	5	4	5	1	5	5	3	20.5	7.8
Yellow nutsedge L .	Tiger Nut	4	2.5	5	1	5	5	5	20.375	7.8
Solanum melongena L .	Eggplant	5	4	5	3	3	1	5	20	7.6
Allium sativum L .	Garlic	1	2.5	5	5	4	5	5	19,875	7.6
Pisum sativum L .	Pea	1	2.5	5	4	5	5	5	19,625	7.5
Cucurbita pepo L . subsp. pepo.	Zuchini	5	4	5	3	2	1	5	19.5	7.4
Lactuca sativa L .	Lettuce	2.5	4	5	5	3	1	5	19	7.2
Cucumis sativus L .	Cucumber	4	4	5	3	3	1	5	19	7.2
Daucus carota L .	Carrot	2.5	2.5	5	4	3	3	5	18,625	7.1
Cynara scolymus L .	Artichoke	4	5	5	2	3	3	3	18.5	7.0
Phaseolus vulgaris L .	Grean beens	1	4	5	3	5	3	5	18.5	7.0
Manihot esculenta Crantz	Casava	5	5	5	1	3	5	1	18.25	7.0
Cichorium endive L .	Endive	4	4	5	2	3	1	5	18.25	7.0
Ananas comosus (L .) Merr .	Pineapple	5	4	5	3	4	3	1	18	6.9
Allium porrum L .	Leek	2.5	2.5	5	3	3	3	5	17,875	6.8
Apium graveolens L . var. sweet Pers .	Celery	4	4	5	1	3	1	5	17.5	6.7
Cynara cardunculus L .	Thistle	1	4	5	1	3	5	5	17.5	6.7
Dioscorea cayennensis subsp. Rotundata (Poir.) J.Miège	Yam	5	4	5	1	3	5	1	17.5	6.7
Raphanus sativus L .	Radish	1	4	5	1	3	5	5	17.5	6.7
Brassica oleracea L . var. italica	Brocoli	2.5	2.5	5	2	3	3	5	17,125	6.5
Brassica oleracea var. botrytis L .	Cauliflower	2.5	2.5	5	2	3	3	5	17,125	6.5
Brassica napus L .	Turnip	1	2.5	5	2	3	5	5	17,125	6.5
Beta vulgaris L . *var. cyclized.* L .	Chard	2.5	5	5	1	3	1	5	16,75	6.4
Spinacia oleracea L .	Spinach	0	2.5	5	4	3	1	5	14,625	5.6

As you can see most crops approved (more than 5 out of 10) but crops the bottom of the table is recommended not to use unless there is no choice because of the availability of seeds.

1.3. Election of varieties

Given the difficulty of obtaining seeds in Gambella, even in Ethiopia, they choose one that is primarily available unless this variety is not clearly fit the weather, in which case it will be an effort to find another variety. If you have access to several varieties, you will choose the best suited to the climate, and if fit alike, buy two, get to know the farm production of each and determine its profitability.

2. ELECTION OF IRRIGATION

2.1. Characteristic of each irrigation system

Then we will summarize the main characteristics of the types of irrigation used in the garden. The three main types are flood irrigation, sprinkler and drip. flood irrigation is not ruled out because the plot is not too big and financial resources are limited and the cheapest of all. However, it should be taken to prevent soil erosion.
For the latter, irrigation runoff is discarded because no data infiltration coefficient for Ostiako formula. It can be obtained by the method of double cylinder.
Among sprinkler irrigation all discarded less micro sprinklers that can be placed under the floor to avoid wetting the leaves as it encourages the emergence of fungal diseases and some pests. It is also ruled out for the same reason any type of irrigation that applies on the ground and not below, as suspended micro irrigation by sprinkling, irrigation and other power forward.
Among drip irrigation, these may be buried or not, in any case are analyzed as if they were one and it does not affect the characteristics analyzed.
Hand watering hose irrigation is another alternative that is not ruled out as the farm is divided by the number of students in the course so hand watering does not require much time per person. In this case we must keep in mind that you can not measure the amount watered with the same precision.

Flood irrigation
Micro spray irrigation
Drip irrigation
Hand watering with a hose

2.1.1. Flood irrigation

This method consists of pouring the irrigation water desired through a hose, pipe or canal, directly in the field, flooding it completely. As a clay soil with low infiltration, it is expected that application uniformity is high with this type of irrigation. It is the cheapest method it does not require piping and materials needed to build an irrigation channel can be easily found in Gambella. In addition, if the work is well designed and executed, it is the least maintenance needs at reducing the need for labor. However, it has other drawbacks as the efficiency of irrigation, erosion, or the appearance of weeds especially the ground instead of being located at a point, which increases the need for labor. It also requires zero slope so it is essential to the development of terraces and ditches which considerably increases the cost of this method because the landscape is slightly wavy. The following summarizes the advantages and disadvantages.

-Advantage:
- Low investment costs
- easy assembly
- Ease of maintenance and low cost
- Materials and workmanship available in Gambella
- Low energy costs
- Not hinder farming

-Disadvantages:
- Soil erosion. Increased costs for their struggle.
- Very poor efficiency
- imprecisely
- Increased costs for the emergence of weeds around the field
- Need a sloping floor 0. Necesitad of terracing.

2.1.2. Micro Sprinkler

The micro spray irrigation is small sprinklers placed at ground level without touching it, which can irrigate up to four plants per sprinkler reducing the installation cost. It is an efficient irrigation and can be easily and accurately regulate the amount of water irrigated. Also, being located, the emergence of weeds decreases considerably during the dry season where rainfall is practically zero. On the other hand, it is a more expensive than the previous system, and requires skilled labor for installation and maintenance. Other disadvantages that are more expensive and more frequent maintenance, especially because of the turbidity of the water has a brown color and is completely opaque because it contains suspended particles that end up clogging the holes in the spray, and increased energy consumption as a minimum working pressure is needed.

-Advantage:

- Little or no soil erosion
- Efficient water use
- Precision irrigation
- Little or no weed for most of the year
- It adapts to the current slope

-Disadvantages:

- Average investment cost high
- Need for skilled labor for assembly
- Average maintenance cost high
- Material and labor not available in Gambella. Need to coach a team.
- means high energy costs
- Difficult farming

2.1.3. Drip irrigation

Drip irrigation pipes is provided small size droppers that provide a flow of very small water drop-shaped. This system is the most efficient in the use of water as it is the one that can be adjusted

more accurately. Furthermore, irrigation is located further than the previous, eradicating the problem of weeds. In areas with difficult access to water, this is the most convenient system allowing you to minimize the maximum consumption. However, it is the most expensive of all because every silver requires a dropper, and its maintenance is also more expensive since the holes are clogged more frequently. The working pressure also tends to be higher so the energy consumption is higher than in micro spray irrigation.

-Advantage:

- No soil erosion
- very efficient water use
- very accurate
- No weeds for most of the year
- It fits any pending (in the case of self-compensating dropper)

Disadvantages:

- High investment cost
- Need for skilled labor for assembly
- High maintenance cost
- Material and labor not available in Gambella. Need to coach a team.
- High energy cost
- Difficult farming

2.1.4. Hand watering with a hose

Given the difficulty of finding money for the project, it is considered the possibility that no funds to carry out any of the three previous systems. In that case, he will opt for hand watering with a hose and a small water pump. This system reduces the maximum investment costs, although labor remains high. The efficiency of water, erosion and appearance of weeds depends upon the precision with which each person watered. This case is not going to discuss with others as it is recommended to apply in the event that no funds for other irrigation are, and for a time as short as possible.

2.2. Irrigation system election

Then will compare the different types of irrigation according to established criteria, and will choose the most convenient irrigation. The criteria evaluated are:

[1] Adaptation to the slope
[2] Investment cost including skilled labor for assembly
[3] Cost of maintenance
[4] Availability of material in Gambella
[5] Energy Cost
[6] Soil erosion
[7] Fight against weeds
[8] Efficient use of water
[9] Accuracy in providing water to the crop, increased performance
[10] Compatibility with farmhands

Each criterion is given a score from 0 to 5. Each criterion is weighted depending on the conditions under which the project is developed. These are:

The criteria [1], [2], [3], [4] and [5] are multiplied by 1, and this project has very few resources so any factor that decreases the profitability of the crop or made more expensive initial investment It is important.

Criteria [6] and [7] are multiplied by 0.75. Weeds are a major problem because the soil is infested seed and much labor is needed to maintain acceptable levels that do not compete with the crop. Soil erosion has the same problem. labor is needed to maintain systems to combat erosion. However, labor in Gambella is very cheap so it does not affect both profitability as the previous ones.

The criteria [8], [9] and [10] are multiplied by 0.5 because although affect the project, are problems that can be overcome without major investments or the need for additional labor. For example, being near the river and have an almost unlimited supply of water, efficient use of water lost economic importance, but not

environmental. Precision water also takes little importance because the crop yield difference between the various methods is minimal.

Thus, the following table, in which the weighted value for each criterion for each type of irrigation, total, and note 10 is shown to compare and see is obtained if the difference between the best irrigation and next it is very large or you can choose both.

Table 2: Ranking of irrigation systems. (Own elaboration)

Type of irrigation / Criterion	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]		Note of 10
Coefficient	**1**	**1**	**1**	**1**	**1**	**0.75**	**0.75**	**0.5**	**0.5**	**0.5**	**Total**	
Flood	1	4	5	5	5	1	1	2	1	5	25.5	6,38
Micro springler	5	3	4	0	3	4	4	4	4	3	26.5	6.63
Drip	5	2	3	0	3	5	5	5	5	3	27	6,75

As you can see, in principle the most suitable irrigation is drip irrigation, followed closely by micro sprinkler irrigation and flood respectively. This is mainly due to the cost and effort to make the terraces to adapt the slope of terreo to flood irrigation, and in the case of micro sprinklers, because the price of these and higher energy costs of this system. Therefore, the installation of a drip irrigation is recommended for farm without prejudice watering by hand until the necessary resources have to invest in an irrigation system.

3. MANAGEMENT ELECTION

In this section they are to choose different alternatives that affect handling during project development. Due to environmental conditions, how isolated it is the farm, at the level of local development, the difficulty of finding supplies and the price of these, the alternatives that will be studied are the type of rotation, obtaining inputs (on all organic) matter, location, and the fight against weeds.

3.1. Rotation

Due to the nature of the project, keep in mind that not every year

can get seeds to carry out the planned rotations. Therefore a number of standards to be met crops to chain them directly and so make the most of soil resources and reduce the risk of pests and diseases is established. The criteria to be followed are:

- No stringing twice crops of the same species, including trying to enter the maximum number species before returning to the first.
- No stringing twice crops of the same family.
- Cultivate a demanding species after a legume or other undemanding plant nutrients such as the take the blade.
- Cultivate a culture of leaf or undemanding after a demanding crop
- Cultivating a crop sheet or legume after a root crop
- Cultivating a culture of fruit after culture sheet or legume
- Cultivating a delicate root crop after a crop with rustic, strong and deep root

This will help consume soil resources in an efficient manner and contribute to improve soil quality. Tubers and fruits often require more nutrients than leaf crops or legumes as the former should not be the fruit and the second fixed nitrogen in the soil which also provides nutrients to the following crop. On the other hand, they should not be chained twice crops of the same family as many pests and diseases have as a guest to all species of the same family, thus the impact of these decreases considerably.

To this must be added the fact that some plants have properties that benefit others. For example, a plant pests can be controlled with another plant that attracts insects that feed on the pest. A few examples of beneficial partnerships are shown below:

Table 3: Beneficial associations. (Source: Provincial Council of Valencia)

Culture	Association ng
Tomato	Cabbage, garlic and onion
Peanut	Corn
Nice	Garlic
Chickpea	Cucurbitaceas and corn
Cabbage	Cucumber and tomato
Eggplant	Garlic
Pumpkin	Onion and corn
Zuchini	Onions, cabbages and corn
Cucumber	Onion and cabbage
Water melon	Onion and corn
Leek	Onion, cabbage and tomato
Onion	Tomato and cucumber
Garlic	Onion and tomato

3.2. Inputs

Get inputs in Gambella is extremely complicated. They must be made from Addis Ababa to reach a distance of two days, when not directly import. In addition, they are extremely expensive as they are imported and tariffs in Ethiopia are very high, so it is only used in case of export the product and sell it at international market price. This difficulty forces to use all possible resources of the estate effectively. On the one hand, obtain organic matter to meet the nutritional needs of the crop and on the other hand should be avoided optimal conditions for pests and diseases to develop. To meet this objective should be reserved 10ha of which get all this, plus or cutting down trees or move the legume family and large trees already present on the farm, without prejudice to the trees above rivera.

This helps to preserve the environment while effectively dampens the impact of pests and diseases. However, it is recommended to gradually replace the trees that are in those 10 ha by others who obtain a product. These are some of the trees or multiannual crops that are well adapted to these conditions: Vanilla, Mango, rubber tree, bamboo, tea, coffee, papaya, cashew nut, nutmeg, cinnamon, avocado, Pistachio, Palma, Datil, Citrus, lychees, custard apple, Atemoya, jackfruit, Pecano, Momordica, Pitaya, cainito, Guarana, Wampi, Cherry great river, Mamey, Rollinia, Pacay, Sapote, Marula, Longan, Asimina, Raimondia, Microcitrus, Banana, Eugenia, canistel, Wooly , Chicozapote, Acerola, Uva beach, Ross,

Synsepalum.

On the other hand, it is advised not to cut the tree legume species already present in the field, not only in the 10 ha but also in the garden, but without ever disturbing the work of operators or the tractor. These trees are able to fix nitrogen in the soil through symbiosis with fungi, and contributed in the form of leaves, branches and dead roots. In addition, its roots in symbiosis with other fungi help increase biodiversity and soil health.

Other trees are advised not to cut large trees as these are able to extract nutrients from inaccessible areas to other trees, and later transfer them to the ground in the same way that legumes very deep roots. In addition, these trees contribute greatly to the health of soils as they are able to transmit nutrients and water through their roots to other trees whose roots are not as deep. This is done through various bacteria, fungi and insects, so cutting these trees seriously affects environmental health and hence soil health and crop production.

3.3. Site

The plot which is available for the project is 30 ha, however, which will be dedicated initially to the horticultural farm is the minimum necessary to carry out the practices of agriculture course, that is 5 ha . More on when the project managers have more practice, it will proceed to increase explodes up to 15 ha. 15 ha of forest will be left for the production of organic matter for the garden and other products such as honey and derivatives, aromatic plants, wood and others. Also keep in mind the proximity of the river and to move the water to the other side of the farm would be an added cost. In addition, near the paved road there is a shallow limestone horizon and many heavy elements which could affect crops.

For all these reasons, the place chosen to develop the garden is in the eastern corner of the farm, as close to the river, but behind the row of large trees rivera you were left as they are because they are essential to avoid erosion during the rainy season.

3.4. Weed control

Due to the environmental conditions of Gambella, there are a lot of flora spontaneous even with minimal moisture conditions. They can compete with the crop to death so that the fight against weeds must be done in a planned way and carefully choose the method that will be used as a general rule to avoid unnecessary expenses. There are several methods to achieve this goal. The first and easier for the operator is to use herbicides. You can also install an anti mesh which herbs are effective but expensive. Another method is heat stroke soil disinfection using a transparent plastic cover. It is less effective than the previous and equally expensive. Finally, it can be done manually using a shovel or rake. mechanization is discarded due to the clayey nature of the terrain.

<u>chemical methods</u>
-Advantage:
- Easy for the operator
- Low investment costs (spray)
- High average efficiency

-Disadvantages:
- Difficult to achieve and need legal permission
- High environmental and toxic impact
- Average cost of use (herbicide must be purchased every few minutes)

<u>antihierbas mesh</u>
-Advantage:
- Moderately easy for the operator
- low cost or no use (the same mesh is used several years)
- high efficiency
- Easy to get (any fabric or black plastic can be used as a mesh)
- No environmental impact and non-toxic

-Disadvantages:
- High investment cost

Soil disinfection:

-Advantage:

- Moderately easy for the operator
- low cost or no use (the same plastic mesh is used several years)
- High average efficiency
- Moderately difficult to achieve (due to the size of the farm)
- No environmental impact and non-toxic

-Disadvantages:

- High investment cost

fight Manual

-Advantage:

- low average efficiency
- Low investment costs
- tools easy to get
- No environmental impact and non-toxic

-Disadvantages:

- Difficult for the operator
- Average cost low usage (labor)

To choose the method that will be used on the farm a value of 0 is given to 5 to each criterion. These are:

[1] Investment cost
[2] Cost of Use
[3] Efficacy
[4] Environmental Impact
[5] Availability of materials
[6] Facility operator

In addition, each value is weighted according to the importance of each criterion for good crop growth and profitability. Thus we have:

The criteria [1], [2] and [3] are multiplied by 1, and the project has

so little funding criteria that directly affect profitability are important.

The criteria [4] and [5] are multiplied by 0.75 because, although it is important not directly affect the project.

The criterion [6] is multiplied by 0.5 in Gambella since the cost of labor is very low.

The following table summarizes where you can see the unweighted values for each criterion, the weighted total value and note 10 is shown.

Table 4: Weed control methods ranking. (Own elaboration)

Method / Criterion	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**		
Coefficient	**1**	**1**	**1**	**0.75**	**0.75**	**0.5**	**Total**	**Note of 10**
Chemicals methods	4	2	3	0	0	4	eleven	4.40
Weed mesh	2	1	5	5	2	3	14.75	5.90
Disinfection	1	1	3	3	1	3	9.5	3,80
Manual fight	4	5	2	5	5	0	18.5	7.40

So, the best choices are fight or manual installation of weed meshes.

ANNEX 3: PROCESS ENGINEERING

Sebastián Sangro Lucas

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1. PRODUCTIVE PLAN

Thanks to the analysis of the alternatives made previously, it has been determined which are the products that can be obtained from the farm and for which they will be used. In the first place, and as the center of the exploitation, are the horticultural products that are going to be cultivated during the classes of agriculture. In addition, other products of the 15 hectares reserved for forest will be obtained. Among these products are honey and its derivatives, aromatic and medicinal plants, wild tubers, wood and charcoal.
On the other hand, replacing the trees of these 15 hectares, other than legumes and large trees, for others such as mangos, cashews, avocados, cherimoya, and others, will end up obtaining a large quantity and variety of tropical fruits at the same time as Preserves biodiversity.

2. PRODUCTION PROGRAM

2.1. Crop cycles

In order to determine crop cycles, many factors have been taken into account:
- A large variety of vegetables will be grown so that crop cycles on the same plot can vary significantly. Cultures are divided by short cycle if they are cycles of 0 to 4 months and long cycles if they are more than 4 months.
-The practices of the course of agriculture, which lasts 4 months and will begin on September 1, January 5 and May 5 of each year, will be taught. In addition, the orchard must provide fresh vegetables to the school and its students.
-In these latitudes the days have the same number of hours all the year, and the temperature is stable. Therefore, irrigation can be sown and cultivated throughout the year. However, it will be taken into account that temperatures between January and April surpass daily 35ºC and that the rains of the months of July and August are torrential and can spoil crops when the plants are still small.

Given these conditions, four different periods of cultivation have been established, depending on the duration of these:

Table 1: Crop cycles sheadule. (Own elaboration)

	September	October	November	December	January	February	March	April	May	June	July	August
Crops												

Table 2: Legend schedule of crop cycles. (Own elaboration)

	1st Cultivation, planting September 1st
	2nd Cultivation, planting January 1st
	3rd Cultivation, sow 1st of May
	Long cycle crops, planting September 1, May 1

Due to the high temperatures, in the 2nd crop will be planted the species best adapted to extreme heat. On the other hand, because in September it still rains considerably, in the 3rd crop will not be those species whose final products have to be allowed to dry for a few days in the soil of the farm. In this way we have the following possibilities of cultivation:

1st crop

All crops

2º Cultivo

Peanut
Chickpeas
Nice
Cantaloupe
Cabbage
pumpkin
Okra
Watermelon
Lemon grass
Tomato
Eggplant
Zucchini

3rd crop

All crops less than 4 months less:

Nice
Beet
Tiger nut
Garlic
Turnip

	Long cycle crops

All crops over 4 months.

In short, there will be 5 crop cycles, long and short cycles, planted in September, January or May, the latter in case of short cycles only. Each begins at the same time as the course of agriculture, so that the students can see the whole process of cultivation.

2.2. Average crop yields

Table 3: Average yields of some vegetables in Ethiopia and South Sudan. (Source: FAO Stat)

Cultivation / Country	Ethiopia	South Sudan
Garlic	10468	4545
Eggplant	SD	19060
Nice	28463	SD
Peanut with peel	1380	552
Pumpkin and Chayote	SD	16666
Casava	SD	1538
Dried onion	10024	19047
Fresh Onion and Shallots	12142	SD
Cauliflower and Broccoli	SD	20000
Beans	1262	3571
Fresh Beans	4133	4687
Chickpea	1710	SD
Ginger	2857	SD
Fresh Vegetables in general	3111	6666
Lettuce and chicory	12500	SD
Fresh vegetables	1568	848
Melons	SD	23000
Okra	SD	11955
Cucumbers and pickles	21428	11904
Fresh Peppers and Chilies	2733	7771
Dried peppers and chilies	285	2000
Pineapple	36363	3750
Leeks and other alliaceous vegetables	5818	SD
Roots and Tubers	7272	SD
Cabbage and other Brasicaceas	10418	6578

Watermelon	SD	19047
Taro	SD	2529
Tomato	7670	14287
Yam	27038	SD
Carrots and Turnips	4505	10119

15 hectares will be dedicated to the cultivation of vegetables and 15 hectares dedicated to forestry.
Below is the yield data for some crops in Ethiopia and South Sudan obtained from the FAO STAT database. This comparison is made because the climatology and soil science are more similar to those of South Sudan, but not all of the species that are grown in Gambella and Ethiopia. On the other hand, it is worth noting the difficulty of obtaining reliable data from remote sites, and that the data do not distinguish between rainfed and irrigated crops, so a large difference can be expected between these yields and those actually obtained on the farm, But gives an idea of what range production will move. In any case, data from South Sudan will be taken into account first because of the similarity of climates and soils, and in the absence of data, performance in Ethiopia will be taken into account.

In general they are low productions, 4 to 15 times less than in developed countries. In addition, these crops will have a low price in the local market.

3. PRODUCTIVE PROCESS

3.1. Establishment of the orchard

The farm has never been exploited, and there is a savanna forest, with trees scattered in ten-by-ten-meter frames and abundant spontaneous flora. Because of this, it is necessary to prepare the ground for its exploitation as a horticultural crop. To do this, you must cut down the trees that are not necessary, remove the large

rocks from the ground, and another series of tasks that fall into 5 categories in order of accomplishment: Removal of trees and large rocks, Weeds and plow, Preparation Of caballeros and Irrigation installation. Only machinery will be used at this stage of the project and in the preparation of the seedbed in each cycle.

3.1.1. Trees and large rocks removal

Choice of trees:

First, you must choose the trees to be removed. Trees contribute greatly to soil fertility so they are beneficial to our crops. They increase the biodiversity of the soil through the symbiosis with numerous fungi and bacteria that facilitate the absorption of nutrients from our crop, and contribute to fertilize the soil with its leaves, branches and dead fruits as they are able to extract nutrients from deep areas of the soil Otherwise they would be lost or take a long time to rise to the surface. Most of the trees belong to the Leguminosae family so they also fix atmospheric nitrogen. For all this, we must try to eliminate the minimum number of trees possible and avoid cutting large trees and legumes. Debris shrubs of less than 2 meters will be removed de facto, and the lower parts will be pruned and cleaned up to 2 m from trees that are not cut so as not to interfere.

Cut of the trees:

The cutting of large trees is very dangerous and must be carried out by specialized personnel. Therefore, in the case of having to cut large trees will hire a specialized company, who has experience in this type of work and has the necessary machinery to do such work. In Gambella, because thousands of hectares of forest have been transformed into croplands in the last few years, there are many companies involved in this activity. Both trees and their stumps should be removed so that they do not disturb agricultural activity.

Shrubs and small trees of less than 2m are removed by hand with the help of axes to cut the trunk and a structure with pulleys to start

the stump if it has large and deep roots or simply with the help of the tractor.

Removal of large rocks

Large rocks larger than 10 cm in diameter will be removed from the ground, which may damage implements, impede the good development of the crop or disturb the agricultural work. Those that are not too large, most of them are removed by hand, and the large ones, weighing more than 30 kg, are removed with the help of the tractor and the contracted personnel. All the stones will be placed forming a line, or a wall if there were enough stones, delimiting the horticultural exploitation and contributing to the fight against the erosion.

3.1.2. Weeds

Due to the virginity of the terrain, there is an evident excess of spontaneous flora that will compete with our crop, being able to get to kill it. This flora is composed mainly of monocots, among which stands out for its abundance and size, elephant grass, *Pennisetum purpureum,* can grow to two meters in less than a month with the first rains in May. It is important to carry out a first cleaning of the seeds that are present in the ground before starting the operation. This will greatly reduce the incidence, and will give a good starting point in the weed control strategy, which is one of the main problems during the rainy season (during the dry season, localized irrigation will be used so the problem will occur On a much smaller surface).

Taking into account the difficult access to chemicals and other methods of combating weeds and the environmental impact they generate, and on the other hand the large amount of flora present on the land, the cleaning will be carried out with the help of a moldboard plow . The parish of Sant Joseph, to which the school belongs, has a moldboard that can be used without additional cost.

The first time you pass the moldboard should be done at minimum

speed as there may still be rocks in the ground that damage the implement. If rocks or other objects are detected, they will be arranged in the same way as the rocks previously removed.
In addition, care should be taken when passing the moldboard near large trees so as not to damage their roots.

This work should be done with the ground in seasoning. In clay soils the soil is very hard when it is dry and very plastic when it is too humid, so finding the soil in seasoning is difficult. During the first rains of May, which can be advanced for about 15 days, the soil becomes slightly seasoned giving a narrow margin of performance. You must have prepared the material beforehand (on April 15) to act quickly before the following rains wet too much soil and can not be turned.

Only landfill implement will be used at this stage of the project since once the first landfill cleaning will be done, as in the other farms that have been visited in the area, with a pair of disc plow passes for the control of bad Herbs

Once the landfill is passed, with the soil still in seasoning, if possible, a plow or disk disc will be given to flatten the soil and close the cracks, on the one hand, to prevent weeds from being able to pass through Ease, and on the other hand to break the blocks of earth and mullir the ground.

3.1.3. Ridge

Once the ground of the ground has been worked, the horses must be formed. They will be made by hand, taking advantage of the furrows left by the disk plow. In the first place, the shape of the horsemen will be marked on the ground with stakes and cables. These will be oriented southeast-northwest, parallel to the river and to the level lines (the land is slightly inclined towards the river). To dispose the horsemen in this way prevents to a great extent the erosion of the soil since the own culture makes of barrier before the water runoff. Once the horsemen have been marked, they must be shaped by hand with the aid of shovels and rakes. Due to the type

of irrigation to be installed, each ridge can contain up to two rows of plants, and the row spacing is approximately 30cm. On the other hand, for easy handling of the crop during all its stages, a sufficient space must be left in the corridors so that it can be worked at the same time and in the same corridor, in the two contiguous horsemen. In this way, the riders must have the following dimensions:

Height patch: 15cm
Patch width: 80cm
Base Width of the Patch: 80 cm
Aisle Width: 80cm

3.1.4. Irrigation Installation

Once the ridges are ready, micro sprinkler irrigation should be installed. The installation should be done by someone with experience. Each spindle of a branch sprinkler rack will be provided with a sprinkler every two plants, ie every 20cm. Although irrigation is not likely to be used from May to September due to abundant precipitation, the installation will be carried out in May along with the other works, as this will be ready for the next crop when irrigation is necessary, and there is not enough time for Install it.

The irrigation system will be composed by micro sprinklers, micro sprinkler branches, branch pipes, primary, secondary and successively. In addition, you must install the water pump that will collect the water from the river, as well as the filters and the booth for the water pump. The latter will have been done previously, during the dry season.

3.2. Preparation of the ground and sowing

Before each cultivation, the seed bed must be prepared and the horses formed. Among other things, this will help to incorporate the organic matter that we contribute and fight against weeds.

Firstly, the spindle-holder branches must be uninstalled so that the tractor can make one or two disc plow blades or toothed discs. If the soil is very dry it will be watered until seasoning before uninstalling the branches. Then, it will proceed just like the first time that the horses are formed, with cables and stakes.

Once the horses have been prepared, the branches will be reinstalled and the sowing will be done according to the species being cultivated in each horse.

If it is not necessary to pass the disk plow, because the soil is soft, there are no weeds and the horse retains its shape, will be planted directly after incorporating the organic matter manually with the help of shovels and rakes, without the need to completely uninstall The branches.

3.3. Cultivation management

3.3.1. Weeds

After sowing, and throughout the crop, but especially at the beginning, when the plants are very young, the spontaneous flora can seriously damage the crop even to kill it. It will be done by hand with the help of a rake and a shovel. This work should be done at least once a week, even twice, until the crop has acquired some resistance. You will not need to hire additional labor for this task.

In case of opting for anti-weed meshes, these must be permeable and must be installed on the horses before installing the irrigation that is installed on the mesh. Holes are made of five centimeters in diameter in a frame of 20 40 cm where the seeds will be planted. It is not necessary that the mesh cover the whole floor of the farm, it is enough that it covers the width of the base of the horse, that is to say 80 cm. There will be no weeds in the corridors during the dry season because it will not be watered, and during the rainy season, the amount of weeds in the corridors will be less than normal by the workers' footprints, so a pass will suffice Scarifier or rake.

3.3.2. Pruning and staking

If necessary, pruning will be done to the crop with the help of pruning shears. The crops that usually need pruning are crops that reach a certain height and climbing crops such as tomatoes or peas. For the latter you must build tutors so that they can grow properly. They will be made at school with metal bars and metal cables as shown in the figure:

3.3.3. O.M.

As explained in the field preparation and planting, it is necessary to incorporate organic matter into the soil before planting, so that it can be thoroughly mixed. This organic matter will be obtained from the rest of the ground in the form of dead leaves fallen fruits, small branches, and green leaves in a given proportion. As mentioned above, legumes and large trees play a very important role in this aspect as they are able to extract nutrients from places that could not otherwise be reached. In this way we will maintain the soil with an acceptable level of fertility, without spending monetary resources.

During the crop cycle, organic matter will be incorporated into the crop in the form of mulching with slightly buried green leaves to provide rapidly available nitrogen, and a layer of dead straw or leaves that will decompose little by little by adding nutrients to the soil. In addition, mulching helps to conserve moisture by reducing evaporation losses by up to 50%. It also helps, among other things, to fight against weeds in corridors and hillocks by preventing the passage of light to the ground, and to combat erosion by preventing the direct impact of raindrops on the ground and slowing the pace Of the runoff water.

3.3.4. Irrigation

During the dry season, there may be months in which not a drop of water falls on the farm so it is imperative to use irrigation during

this time. During the rainy season, from May to October, 1200 mm fall so in principle irrigation is not necessary. Nevertheless, during the last years the rains of May are increasingly irregular and torrential reason why it is foreseeable that it is necessary to use the irrigation during the first stages of the crop, when the plants are still delicate and they do not resist well to the lack of Water.

Due to the large number of vegetables to be planted, the choice of irrigation scheduling and the design of this should be done based on an average of water needs of the crops. These are classified into three groups, crops that need lots of water, those that need a medium amount, and those that need little water.

In any case the irrigation of the farm must be handled by the foreman or professor of practices since it must be done accurately and continuously.

3.3.5. Harvest

The harvesting will be carried out by hand, with the help of pruning shears, for vegetables like tomatoes, with knife for lettuce and others. The products will be moved in boxes with the help of a wheelbarrow to the pick-up that will take them to the school for storage in refrigerators. Apart from having crops whose crops are staggered, the more species are cultivated at the same time, the more scaled will be the harvesting. In this way, you can get all kinds of vegetables throughout the year.

3.4. Needs

3.4.1. Workforce

The hiring of unskilled labor is essential throughout the growing cycle. Among other daily tasks, these should prepare the land and the seedbed, weed out once or twice a week, install tillage, collect crops, clear crops, collect organic matter from the rest of the farm and incorporate it Soil, make and preserve mulching and plant trees in the 15 hectares reserved for this purpose. Due to the seasonality

of these tasks, day laborers will be hired for these jobs if needed. It is estimated that for each hectare will be necessary 2 people to carry out all the tasks in time. Therefore, during the practice sessions carried out by the school, the need for unskilled labor is well covered.

For monitoring the crop, which has to be carried out 24 hours a day, due mainly to wild animals, but also to petty thefts, requires the hiring of security guards. It is calculated, based on what has been seen on other farms in the area, that a guard is needed for every 5 ha. That is to say that when the farm is at full capacity with the 15 has exploited will be needed 3 guards to monitor the crops day and night.

The irrigation and the water pump must be handled by someone with knowledge in the matter. For this, a specialized worker must be hired. In the farms around this is usually the foreman, who in this case will be the professor of agricultural course practices so it is not necessary to hire specialized personnel.

Finally, when necessary, tractors from the parish of Sant Joseph will be used, with several, as well as experienced drivers. Therefore, apart from gasoline, the use of the tractor does not involve an additional expense in labor.

For the establishment of the orchard, before beginning the course of agriculture, it is necessary to hire workers to prepare the soil (tractor) to create the caballeros (unskilled labor) to install irrigation (specialized and non-specialized labor) and install The electric fence (skilled and unskilled labor). As before, it is estimated that it takes 2 workers per hectare and a tractor and its driver for 5 ha, to carry out the work on time. The trainee teacher is qualified to carry out the installation of the irrigation and electric fence.

The following table summarizes the labor needs:

Table 4: Labor requirements. (Own elaboration)

Type / Year	1	2	3 and following
Not specialized	10	twenty	30
Tractor driver	1	1	1
Guards	1	2	3
Foreman / Teacher	1	1	1

3.4.2. Tools and materials

All workers must be able to be doing the same work at the same time since as a general rule the work is done in a specific order and with a concrete tool. Therefore, it is necessary that there be as many tools as workers. In this way, they are needed for each hectare of exploitation:

-2 Large blades
-2 Rakes
-2 Hoes
-2 Peaks
-2 Hors d'oeuvres
-2 Pruning shears
-2 Knives for harvesting
-1 Wheelbarrow
-1 Pick-up or trailer for tractor (for the whole farm)

3.4.3. Fertilization

Fertilization needs must be covered to the maximum through the incorporation of organic matter. There is no access to chemical fertilization so it will be almost impossible to cover all the needs of the crop or what is the same, that has the maximum possible yield. In return, the soil will be maintained with a level of organic matter of 3% which is a correct amount pulling rich taking into account the pH and soil texture. Further on, the contribution of nitrogen through the mineralization of organic matter will be calculated.

On the other hand, a distinction must be made between the two major fertilizers to be disposed of. These are dried vegetable

remains, and vegetable remains in green. The former are incorporated before planting since they have a high nitrogen carbon ratio so at first the soil fungi and bacteria immobilize the nitrogen, to release it later when the fungus dies. The green manure is incorporated with the crop already grown since it has a higher concentration of proteins and therefore a low carbon nitrogen ratio causing the nitrogen to be released immediately and making it available to the plants.

When passing the moldboard to eliminate weeds first, mix the first 40 centimeters of soil. Therefore, to know the amount of organic matter in the first 30 cm at the time of sowing, which is the depth to be taken as a reference for root depth of the different crops, the average should be done with the data Obtained from the ISRIC:

Table 5: Organic matter in the soil. (Own elaboration)

PROPERTIES / DEPTH (cm)	**0-5**	**5-15.**	**15-30**	**30-40**
Organic matter (%)	7.1	3.3	2.8	1.5
DIAGNOSTIC MO	Excessive	rich	Right	Very poor
Volume (m ^{3} / ha)	500	1000	1500	1000
Bulk density (t / $^{m3)}$	1.3	1.3	1.3	1.3
Floor weight (t)	650	1300	1950	1300
Quantity MO (t)	45,838	42,484	53,664	20,124
PROPERTIES / DEPTH (cm)	**0-40**			
Organic Matter (t)	162.11			
Volume ground (m ^{3} / ha)	4000			
Floor weight (t)	5200			
% O.M.	3.11			
Diagnostics O.M.	rich			

As can be seen, after having mixed the first 40 cm of soil, the proportion of organic matter in the soil is 3.11%, and is defined as a soil rich in organic matter. Therefore it will not be necessary to increase the levels and it will suffice to keep them at 3%. This way you have:

S = Surface in m ^{2} = 10000
P = Depth in m = 0.3
Da = Bulk density T / m ^{3} = 1.3
% MS $_{dry}$ = Percentage of dry matter to dry residues = 70

% more $_{fresh}$ = Percentage of dry matter for fresh waste = 17.5
k $_{1secos}$ = isohumic coefficient for dry = 0.15 waste
k $_{1frescos}$ = isohumic coefficient for fresh = 0.25 waste
k $_{2}$ = coefficient of mineralization to clay loam soils in warm tropical climate = 0.06

To maintain organic matter levels year after year:

$$T\ de\ M.O.que\ se\ pierden\ al\ año/ha\ (Mineralización) = k_2 * S\ \times\ p\ \times\ Da\ \times\ \%MO$$

$$Mineralización = 0{,}06 * 10000 \times\ 0{,}3\ \times\ 1{,}3\ \times 0{,}3 = 7.02$$

It is calculated taking into account that 2/3 of the total contribution will be made in April in the form of dry leaves and 1/3 during the year distributed in the form of green leaves, when the crops are developed and the nitrogen requirements increase And that in addition only the horses will be fertilized, that is to say 50% of the surface.

$$\text{T de residuos}\frac{\text{secos}}{\text{ha}} = \frac{\frac{2}{3}\text{Mineralización}}{\%\text{ms}_{\text{secos}}\ \times\ \text{k}_{1_{\text{secos}}}} \times 0{,}5$$

$$\text{T de residuos}\frac{\text{secos}}{\text{ha}} = \frac{\frac{2}{3} \times 7{,}02}{0{,}7\ \times\ 0{,}15} \times 0{,}5 = 22{,}14$$

$$\text{T de residuos frescos/ha} = \frac{\frac{1}{3}\text{Mineralización}}{\%\text{ms}_{\text{frescos}}\ \times\ \text{k}_{1_{\text{frescos}}}} \times 0{,}5$$

$$\text{T de residuos}\frac{\text{secos}}{\text{ha}} = \frac{\frac{1}{3} \times 7{,}02}{0{,}175\ \times\ 0{,}25} \times 0{,}5 = 26{,}74$$

Therefore, each year in February or April, taking advantage of the large amount of dry waste on the farm, 22.14 tonnes of dry waste and 26.74 tonnes of fresh waste will be extracted from it. This annual waste incorporation will maintain organic matter levels at 3%. The dry residues are incorporated in April because, due to their high C / N ratio, the soil nitrogen is sequestered to release it throughout the year. The fresh residues must be supplied before flowering because, due to their low C / N ratio, a release of the nitrogen in the soil solution is made available to the plant. However, due to the seasonality of the rains, it is not possible to obtain fresh or dry residues during the whole year, and the school does not have the means to accurately measure the amount incorporated. For this and to simplify the tasks, once a month will proceed to the collection of organic matter in the wooded part of the farm.

This large amount of organic matter can not be supplied by the wooded part of the farm, since according to the agricultural productivity index of Turc, it will be possible to obtain around 25 tons per hectare per year, so organic matter must be obtained from Off the farm.

Next, we calculate the amount of nitrogen that was supplied to our crop each year:

% Nitrogen relative to dry matter in fresh residues = 2
% Nitrogen with respect to dry matter in dry residues = 1

Nitrogen supply with 22.14 tonnes of dry waste = 0.156 tonnes of nitrogen

Nitrogen supply with 26.74 tonnes of fresh waste = 0.93,5 tonnes of nitrogen.

Total input = 0.250 tonnes of nitrogen.

In total, approximately 250 kg of nitrogen is added to the soil each year with the incorporation of vegetable residues from the rest of the farm.

3.4.4. Irrigation (Continuous flow and programming)

Due once again to the great variety of species to be cultivated, the possibility of growing all year round and the need to adapt to the course of agriculture, a series of irrigation schedules have been elaborated according to the water needs (low, Medium or high), planting time (1 September, 1 January or 1 May) and depending on whether it is a crop with a cycle of more or less than 4 months. In this way there are 18 possibilities of irrigation programming, 9 cycles less than 4 months and 9 cycles greater than 4 months. For this, the FAO Cropwat program has been used and the continuous flow has been obtained to irrigate each month, as well as the total monthly amount, daily and for every 10 days. Cropwat takes into account for its calculations, among others, the climatic factors of Gambella, effective precipitation according to the USDA method, real crop evapotranspiration (ETc), planted area (50%) and soil water properties (CRAD = 100mm).

In this case the following values have been used for the crop evapotranspiration coefficient (Kc):

- short cycle crops (110 days)
Needs low: $_{initial}$ = 0.4 Kc (30 days); Kc $_{development}$ = linear from 0.4 to 1.05 (30 days); Kc $_{fruct}$ = 1.05 (35 days); Kc $_{maturation}$ = linear up to 0.35 (15 days)

Average needs: $_{initial}$ = 0.5 Kc (30 days); Kc $_{development}$ = linear from 0.5 to 1.1 (30 days); Kc $_{fruct}$ = 1.1 (35 days); Kc $_{maturation}$ = linear up to 0.6 (15 days)

Needs low: $_{initial}$ = 0.6 Kc (30 days); Kc $_{development}$ = linear from 0.6 to 1.15 (30 days); Kc $_{fruct}$ = 1.15 (35 days); Kc $_{maturation}$ = linear up to 0.9 (15 days)

- long cycle crops(165 days)

Low needs: $_{initial}$ = 0.4 Kc (40 days); Kc $_{development}$ = linear from 0.4 to 1.05 (60 days); Kc $_{fruct}$ = 1.05 (50 days); Kc $_{maturation}$ = linear up to 0.35 (15 days)

Medium needs: $_{initial}$ = 0.5 Kc (40 days); Kc $_{development}$ = linear from 0.5 to 1.1 (60 days); Kc $_{fruct}$ = 1.1 (50 days); Kc $_{maturation}$ = linear up to 0.6 (15 days)

High needs: $_{initial}$ = 0.6 Kc (40 days); Kc $_{development}$ = linear from 0.6 to 1.15 (60 days); Kc $_{fruct}$ = 1.15 (50 days); Kc $_{maturation}$ = linear up to 0.9 (15 days)

Depending on the crop to be planted at that time and on that plot, one or another irrigation program will be used. For example, tomato has a cycle of more than 4 months and high water needs, and can be planted in September, January or May.

In this way, the following irrigation schedules have been obtained:

For short cycle crops

Table 6: Water needs of short cycle crops. (Source: FAO CropWat)

Low needs												
Flow / Month	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Sea**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Mm / day	0	0.4	1.6	0.9	0.9	1.9	2.4	0.9	0	0	0	0
Mm / decade	0	3.6	16.2	9.3	9.5	17.3	24.7	9.4	0	0	0	0
Mm / month	0	10.9	48.5	28.0	28.6	51.9	74.0	28.2	0	0	0	0
L / ha.s	0	0.0	0.2	0.1	0.1	0.2	0.3	0.1	0	0	0	0

Medium needs												
Flow / Month	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Sea**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Mm / day	0	0.5	1.7	1.1	1.2	2.1	2.5	1.2	0	0	0	0
Mm / decade	0	4.7	17.3	11.3	12.1	19.2	26.0	11.7	0	0	0	0
Mm / month	0	14.0	51.9	33.9	36.4	57.5	78.1	35.2	0	0	0	0
L / ha.s	0	0.1	0.2	0.1	0.1	0.2	0.3	0.1	0	0	0	0

High needs												
Flow / Month	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Sea**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Mm / day	0	0.6	1.8	1.3	1.4	2,3	2.7	1.4	0	0	0	0
Mm / decade	0	5.7	18.4	13.6	14.7	21.0	27.4	14.5	0	0	0	0
Mm / month	0	17.1	55.3	40.7	44.2	63.1	82.2	43.5	0	0	0	0
L / ha.s	0	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0	0	0	0

Table 7: Key Table 6: water requirements of short-cycle crops. (Prepared)

	Seeded on 1 September and harvested until 20 December
	Sown on 1 January and harvested until 20 April
	Strewn on 1 May and harvested until August 20

And for cycles over 4 months

Table 8: Water needs of long-cycle crops. (Source: FAO CropWat)

Low needs

Flow / Month	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Sea	Apr	May	Jun	Jul	Aug
mm / day	0.0	0.0	0.0	1.1	2.2	0.9	1.1	1.7	1.9	0.0	0.0	0.0	0.0
		0.2	0.1			2.5	0.7			0.5	0.0		
mm / decade	0.0	0.0	0.4	10.7	23.1	9.5	10.6	17.1	19.2	0.0	0.0	0.0	0.0
		1.7	0.6			26.3	6.2			5.2	0.0		
mm / month	0.0	0.0	1.1	32.2	69.4	28.6	31.9	51.2	57.6	0.0	0.0	0.0	0.0
		5.1	1.7			79.0	18,6			15.5	0.0		
L / ha.s	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0
		0.0	0.0			0.3	0.1			0.1	0.0		

Medium needs

Flow / Month	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Sea	Apr	May	Jun	Jul	Aug
mm / day	0.0	0.0	0.1	1.2	2.4	1.2	1.4	1.8	2.1	0.0	0.0	0.0	0.0
		0.2	0.1			2.7	0.9			0.6	0.0		
mm / decade	0.0	0.0	1.1	12.3	24.4	12.1	13,0	19.0	20.6	0.0	0.0	0.0	0.0
		2.4	1.0			27.7	8.2			6.4	0.0		
mm / month	0.0	0.0	3.3	36.9	73.1	36.4	39.1	57.1	61.8	0.0	0.0	0.0	0.0
		7.3	3.1			83.2	24.6			19.1	0.0		
L / ha.s	0.0	0.0	0.0	0.1	0.3	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0
		0.0	0.0			0.3	0.1			0.1	0.0		

High needs

Flow / Month	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Sea	Apr	May	Jun	Jul	Aug
mm / day	0.0	0.0	0.2	1.4	2.5	1.4	1.7	2.0	2.2	0.0	0.0	0.0	0.0
		0.3	0.3			2.8	1.1			0.7	0.1		
mm / decade	0.0	0.0	1.8	13.9	25.6	14.7	15.4	21,0	22.0	0.0	0.0	0.0	0.0
		3.5	2.9			29.1	10.4			7.6	0.9		
mm / month	0.0	0.0	5.4	41.6	76.7	44.1	46.2	63.0	65.9	0.0	0.0	0.0	0.0
		10.4	8.6			87.3	31.3			22.7	2.6		
L / ha.s	0.0	0.0	0.0	0.2	0.3	0.2	0.2	0.2	0.3	0.0	0.0	0.0	0.0
		0.0	0.0			0.3	0.1			0.1	0.0		

Table 9: Key Table 8: Water needs of long-cycle crops. (Prepared)

	Sown on 1 September and harvested in mid to late February
	Sown on 1 January and harvested in mid to late June
	Strewn on 1 May and harvested in mid to late October

ANNEX 4: DESIGN ENGINEERING

Sebastián Sangro Lucas

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Next, we will detail the spatial arrangement of the facilities, the orchard, as well as the location of the irrigation house for optimal use of resources and thus justify the solutions chosen in the annex Engineering of the production process

1. Design

1.2. Site

Several factors have been taken into account in choosing the location of the farm. In the first place and as a more important factor have chosen the places closest to the river that do not suffer floods during the rainy season. Areas with fewer trees were then selected. Finally, the area with the lowest slope was chosen.
As a result, the first five hectares will be located parallel to the river and 100 m east, in the northeast corner of the farm, as shown in the following figure.

1.2. Size, shape and orientation

During the first three years, 15 ha of cultivation will be established at a rate of 5 ha per year. The orchard has been designed so that each of these five hectares is a differentiated block divided by a central path. In turn, each block is divided into sub-plots of half hectare. In this way it is possible to separate easily the different crops are going to be planted or to allocate parcels to the students. The subplots are the size of a family farm in Gambella, about half a hectare, and are arranged in two rows of five subplots, one in front of the other, separated by the central road. The dimensions of the subplots are 100 × 50 m, which is a form that facilitates manual tasks since not being too long do not go that much distance to the central path where the product is loaded in the pickup or trailer. Finally, the orientation of the subplots is southwest northeast, leaving the length in the direction of the contour lines. In the following figure you can see the layout of the subplots.

1.3. Ridge orientation

The horsemen are designed to be able to work on them manually, with enough spaces between them so that several people can work and move. In each ridge there are two lines of plants, each accessible from one side of the ridge. The dimensions are 80 cm wide for the base, 15 cm high, and 100 m long. The planting frame is 20 × 40 cm. This frame allows to cultivate all the vegetables conveniently as it leaves enough space to manipulate the plants and also grow healthy. The separation between caballerias is of 80 cm, enough so that a person can circulate carrying some object while others are manipulating the plants. In this way, 50% of the surface is covered with crops.

1.4. Roads and paths orientation

The central road will be six meters wide so that a large car or a tractor can move, and also people can circulate on both sides of this and load the products. In addition, there will be a road around the block, at least three meters wide to allow the passage of cars or tractors and people, which will serve to reach every corner of each block, as well as serve as the first barrier to animal safety wild. The subplots are separated by rows of stones to be placed at the time of establishment of the holding.

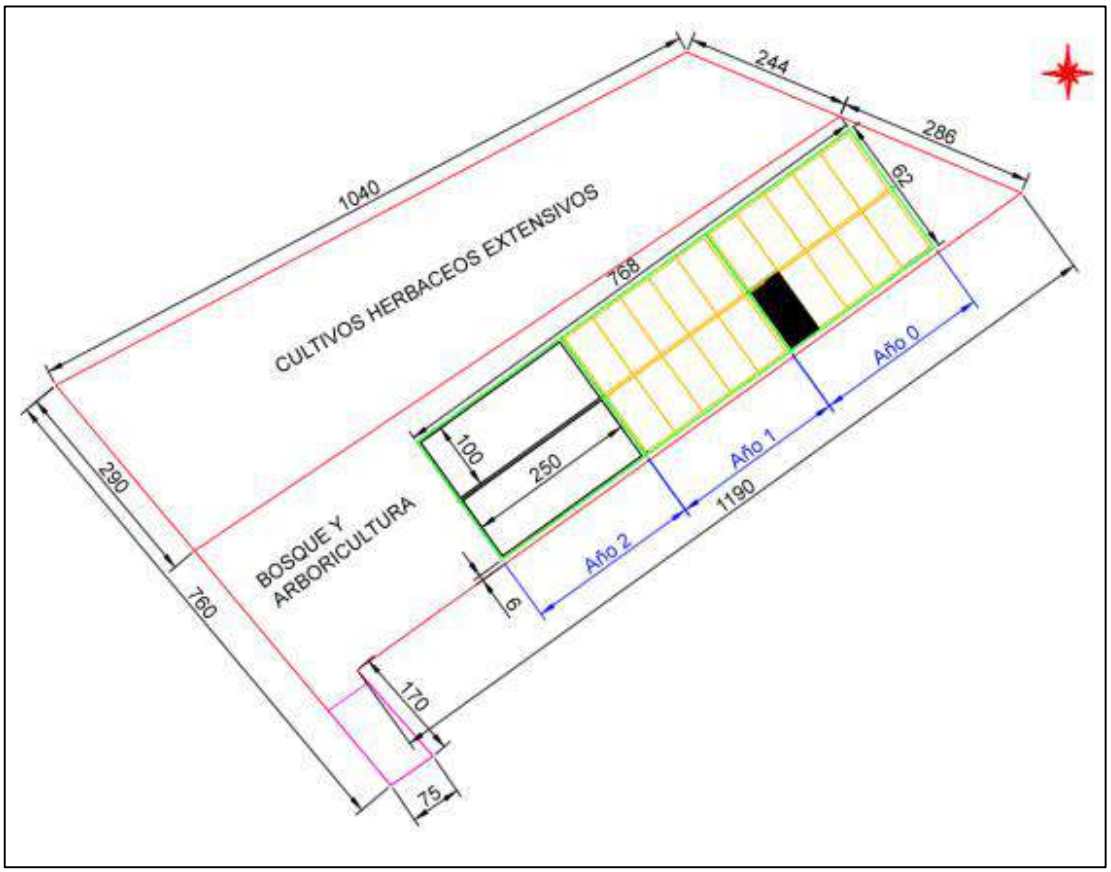

Figure 1: Arrangement of plots and subplots on the farm. (Own elaboration)

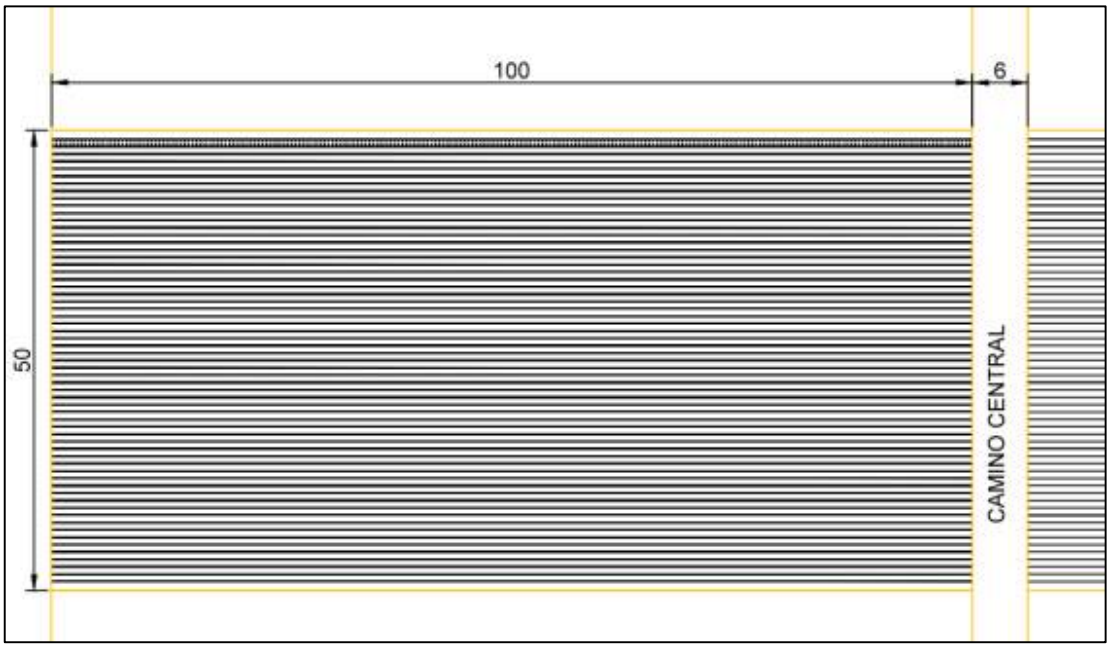

Figure 2: Layout and size of the subplots. (Own elaboration)

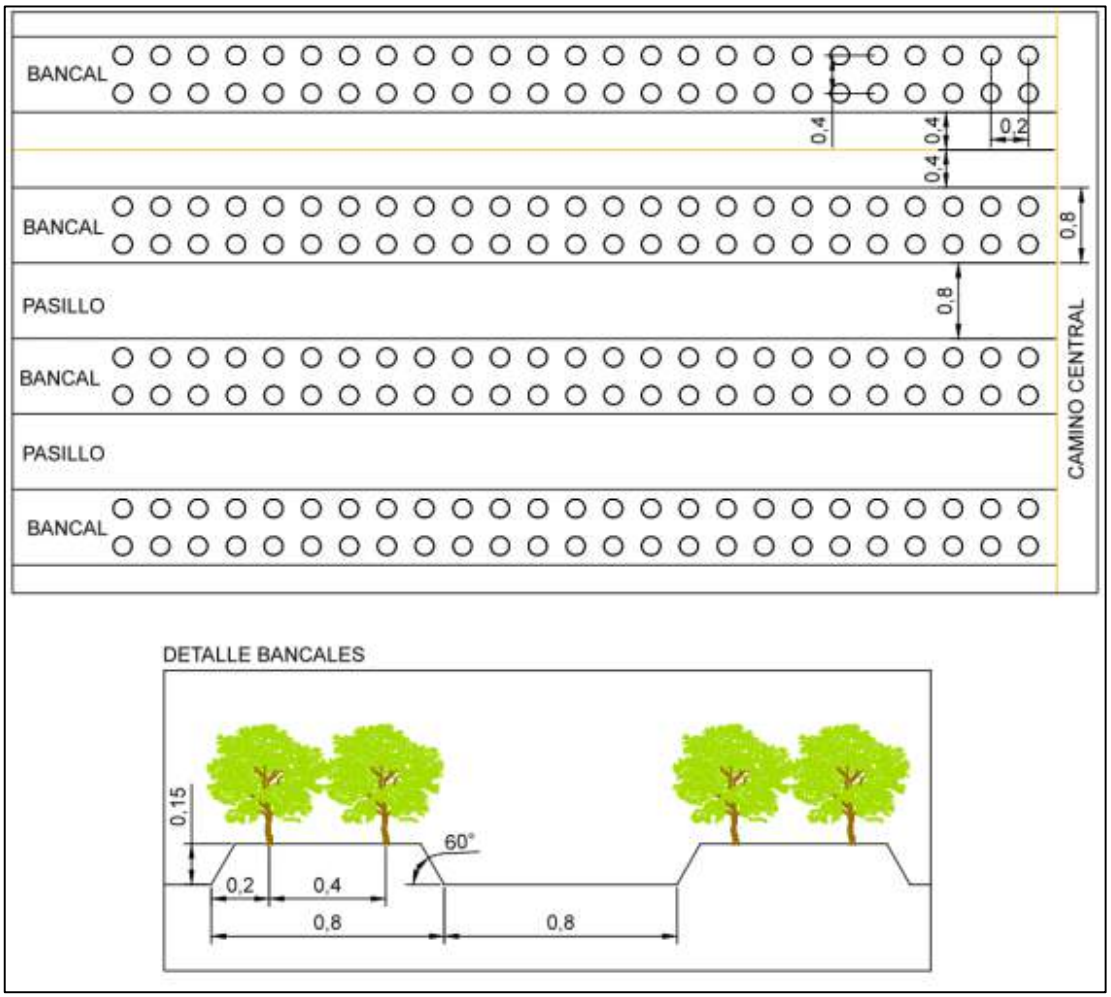

Figure 3: Detail of ridges and corridors between ridges. (Own elaboration)

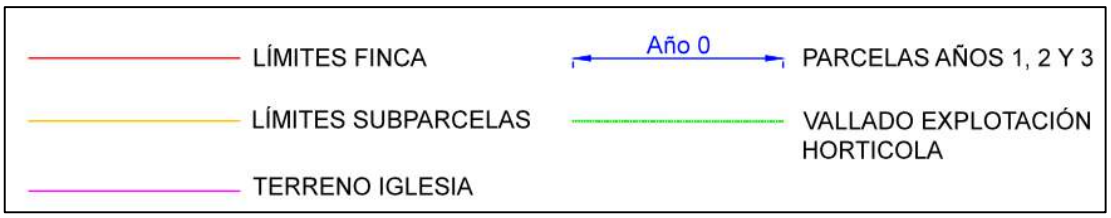

Figure 4: Legend figures 1, 2 and 3. (Own elaboration)

2. Irrigation Design

For irrigation design, the layout and size of the subplots have been taken into account, compared to the river. The irrigation house, where the pump will be housed, will be built as close as possible to the river, so that the suction pipe is as short as possible, ie at the edge of the farm, 100 m from the river. On the other hand, each ridge will have a drip tray that will be placed in the middle of the ridge along the 100 m, with a gap between 20 cm. The branch pipe runs perpendicular to the branches and parallel to the road and runs through the entire subplot. On both sides of the road run the two primary pipes. The latter is connected to the portaramales through a short connecting tube placed in the center of the portaramales pipe. Finally, the primary pipes are joined in the secondary pipe, which reaches the pump directly.

The primary, secondary and suction pipelines will be buried 60 cm deep.

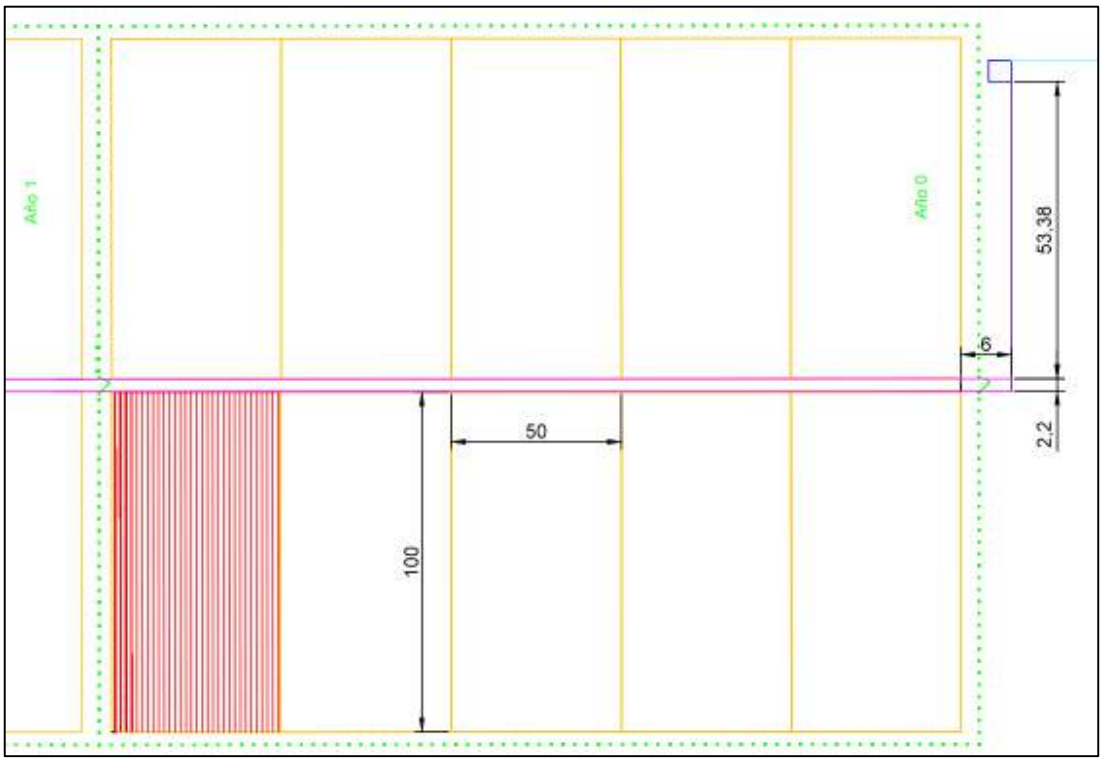

Figure 5: General scheme of irrigation. (Own elaboration)

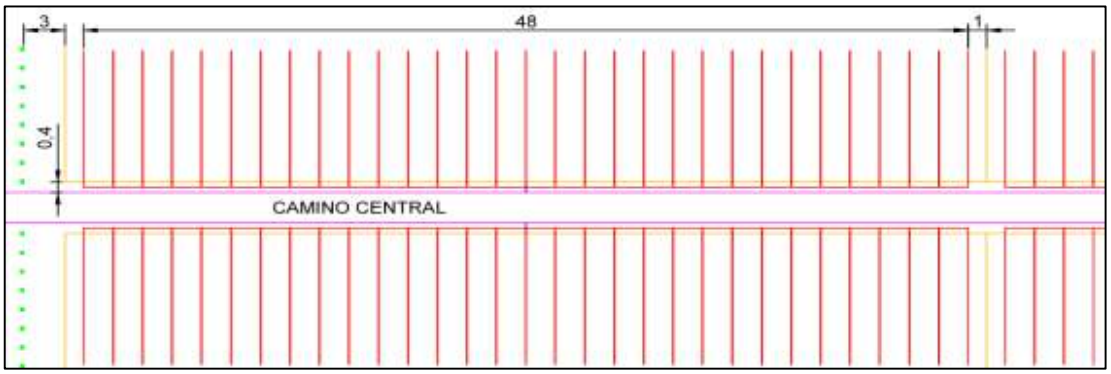

Figure 6: Arrangement of branches and porta branches in subplots. (Own elaboration)

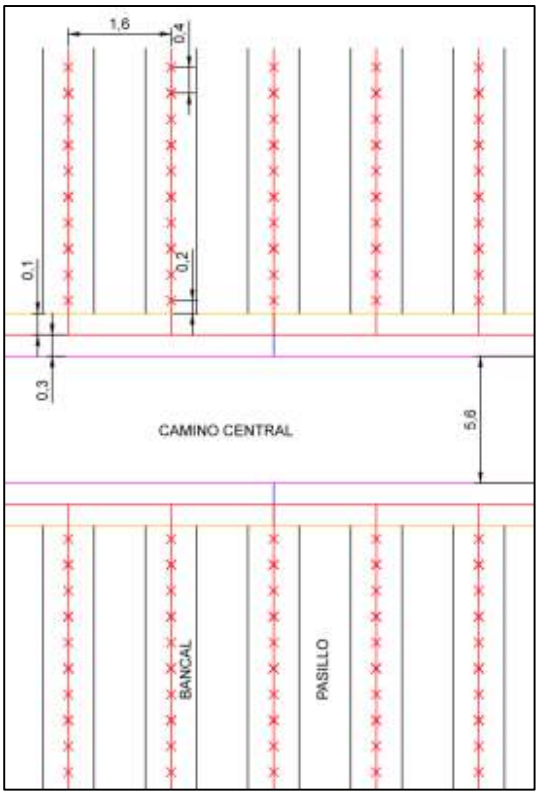

Figure 7: Subplot detail and droppers' frame. (Own elaboration)

Figure 8: Legend figures 5, 6 and 7. (Own elaboration)

ANNEX 5: ENGINEERING OF WORKS AND INSTALLATIONS

Sebastián Sangro Lucas

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1. WORKS ENGINEERING

1.1. Introduction

The building that is proposed in this project consists of a prefabricated house where the pump, the filters, the protection box to control the pump and the controls of all the hydraulic installations will be housed.

1.2. Pump booth

1.2.1. Dimensions

-Dimensions: three meters wide by three meters long and 2.4 meters high

-Solera: Its will be concrete HN-25 of 15 cm thick with mesh of 15 × 15 cm and bars of 6 mm in diameter. In addition there will be a 30 cm deep lawn to avoid the rise of water by capillarity.

-Walls: Cement bricks 40 × 25 cm and 10 cm thick

- Cover: Fibrocemento granudo covered with asphaltic fabric three millimeters thick; To waterproof the structure

1.2.2. Access and windows

-Access: Sheet metal door two meters high by one meter wide with reinforced lock

-Windows: two windows with safety glass of one meter wide by half a meter high

1.2.3. Ventilation

The booth will have two 0.25 × 0.25 m ventilation grilles located at the bottom of the booth, one at the top and one at the bottom

to improve ventilation. In addition, the smoke outlet of the pump goes directly to the outside through a 10 × 10 cm outlet located in the lower part of the wall adjacent to the pump.

1.2.4. Fire Safety

You will have a fire extinguisher to prevent possible accidents and should be monitored whenever it is in operation.

1.2.5. Construction

The construction will be carried out by local masons and the materials will be acquired in the local market.

2. FACILITY ENGINEERING

2.1. Irrigation

2.1.1. Crop hydric needs and continuous flow

Since it is possible to choose the pump, and with it the flow rate with which we work, then in this case the limiting factor is the water needs in the month of greater needs for the crop with greater needs, and the time that we want to devote to irrigation . These needs are assumed for the extreme case in which the 15 ha are planted with the crop with higher water requirements. These needs are presented in the month of January for crops with high water needs, with a long cycle, and the net sheet to be provided is 87.3 mm, as seen previously in PRODUCTION PROCESS. On the other hand, only 50% of the plots are sown, therefore, the actual net sheet to be provided is 43.65 mm.

Since this amount must be irrigated in January, ie 31 days, the minimum continuous flow needed to irrigate 15 ha in time is 2.44 L / s and 8800 L / h. However, it is recommended that the flow is

approximately double, so that the irrigation time is reduced by half, that is to say to 15.5 days approximately, in addition to saving gasoline and labor, to be able to have the pump to Watering plots of other farmers in the area and making the most of the pump.

2.1.2. Dropper election

Once the required minimum flow rate is known, and the number of droppers per subplot, the minimum flow rate of each dropper is determined for its subsequent choice, as shown below:

With:
Q (L / h) = Dropout minimum flow rate
Q (L / h) = Minimum flow required

$$q\left(\frac{l}{h}\right) = \frac{Q\left(\frac{l}{h}\right)}{n^{o}goteros}$$

$$q\left(\frac{l}{h}\right) = \frac{8800\left(\frac{l}{h}\right)}{7750\ goteros} = 1{,}14$$

The minimum flow per dropper required to water the 15 ha, sown at 50%, is 1.14L / h and it would take 31 days to irrigate.

A dropper from the company's Naandanjain catalog has been chosen to comply with the previously imposed condition of providing twice the flow to irrigate in half the time. The chosen dropper was the brown model, which provides 2L / ha with an operating pressure of between 1 and 4bar (self-compensated dropper) and a coefficient of variability (CV) of 4%.

Once the dropper is chosen, the time required to irrigate the plot is calculated:

$$t(h) = \frac{43{,}65(L/m^2) \times 10000(m^2/ha) \times 15(ha)}{7750\ (goteros) \times\ 2(\frac{l}{hora \times gotero})} = 422\ horas$$

With this dropper, the total irrigation time in the month of January, in which the longest time has to be on the pump, will be 422 hours, that is 17.6 days. There will be 13 extra days available to either help other farmers in the area or increase the area of the farm.

Finally, soil infiltration is checked to avoid watering. The infiltration capacity of well-clayey loamy loam soils is about 15 mm / h. For the selected drippers (2L / h) and with the chosen dropper frame (40x40cm), the rainfall intensity is 12.5 mm / h, therefore, there is no risk of watering.

2.1.3. Water pump election

It is necessary to know the power of the pump, and the column height of water to be supplied to the circuit, in order to determine the maximum amount of charge loss that can be given in said circuit and thus calculate the size of the pipes That will be used. For the selection of the pump, the following data are taken into account:

Height difference between river and pump: 4 m
Height difference between pump and last dropper: 7m
Minimum pressure required in the last dropper: 11mca
Maximum pressure in the first dropper: 40mca
Total pressure height required without counting loss of load in circuit: 4 + 7 + 11 = 22mca
Flow rate to be provided: 7750 droppers × 2L / h.gotero = 15500 L / h

A pump has been chosen from the Genergy brand catalog, whose yield graph is shown below:

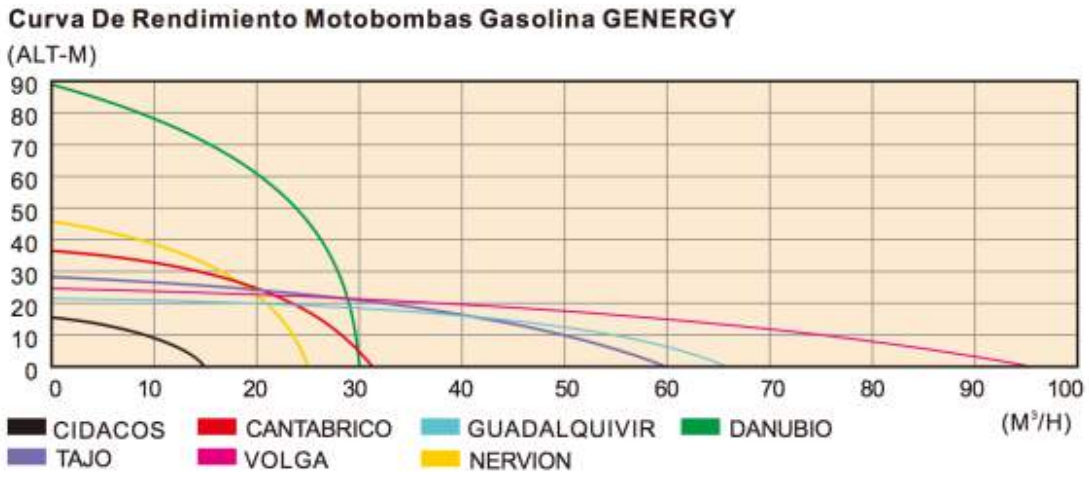

Figure 1: Performance curves of gasoline motor pumps. (Source: www.genergy.es)

As you can see with the help of the brands, the "CANTABRICO" motor pump gives us 15500L / h with 30 mca. Therefore, discounting the 22 mca needed to cope with differences in height and dropper pressure, there remain 8 mca for load losses along the whole circuit, from the river to the last dropper, although only Will use 7mca to leave a margin of 1mca against possible errors. In any case, working at any point below 30mca the pump always provides 15500L / h since the flow is limited by the drippers.
Under these conditions, according to the catalog provided by Genergy, the consumption of gasoline is 1.28 L / h.

2.1.4. Hydraulic calculations

2.1.4.1. Criteria

Next, the calculations made for the choice of the diameter of the pipes and the different components that make up the hydraulic circuit of the irrigation are detailed.

It has been calculated previously that the maximum allowable losses in the circuit from the river to the farthest dropper are 7mca. These losses must be distributed between different components of the circuit such as pipes, filters, elbows and others.

For this, a series of criteria is established that will allow to obtain realistic diameters and with a certain homogeneity in the circuit. The criteria are:

- Of the 7mca are distributed 6mc for losses of load in pipes and 1mca for losses of load in singular points.
- Of the 6mca of losses of load in pipes, 3mca are given in the subplots (portaramales and branches) and 3mca are given in primary, secondary and suction pipes.
- Of the 3mca of losses of load in the subplot, 75% is lost in the branch and 25% in the portaramal.
- Of the 3mca of loss of load in the primary, secondary and suction pipes are distributed evenly.
-The resulting pipe diameters should not have a size ratio greater than 2.5.
- The commercial diameter is chosen bigger and more adjusted to the calculated diameter.

The list of components of the circuit and the losses of load for each section according to the established criteria are:

Table 1: Permissible load losses in each section. (Own elaboration)

Component	Pressure Lose	Length (m)	hf according to criteria (mca)	
Suction pipeline	hf_{suc}	120		
Secondary pipeline	hf_{2}	200	1	
Pramiry pipeline	hf_{1}	750	2	3
Dropper pipeline holder	hf_{port}	48/2	0.75	
Dropper pipeline	hf_{ram}	100	2.25	3
Filters	hf_{f}	X		
Elbows 90 °	hf_{c}	X		
Pipeline conection	hf_{with}	0.1	1	

2.1.4.2. Pipelines dimeters calculation

2.1.4.2.1. Sprinkler line and sprinkler line holder

To determine the load losses that will occur within each section, we have to apply a reduction factor (F) that allows to realize that not all the flow reaches the last dropper, but it is divided between the different exits, and Thus reducing the load losses.
Therefore, this reduction factor is necessary to determine the load losses from which we are going to size the block branches.

$$hf_r = F \times hf_{Dr}$$
$$hf_{pr} = F \times hf_{Dpr}$$

Its value depends on a constant (m) which in turn depends on the hydraulic regime of the water passing through those branches. Since our pipes are made of plastic material, the equation we use to determine the load losses is Blasius where the flow rate is high M = 1.75 so:

$$F = \frac{1}{1+m} + \frac{1}{2N} + \frac{\sqrt{m-1}}{6N^2}$$

And clearing the diameter of the Blasius equation we have:

$$D(mm) = \sqrt[4,75]{\frac{0,465}{2,75} \times \frac{Q_{(l/h)}^{1,75} \times L_{(m)}}{hf_{D(m)}} \times \frac{1+L_{eq}}{S_g}}$$

Next, the summary table shows the calculated diameters according to the permitted load losses according to criterion, the chosen commercial diameters, and the load losses with these diameters.

Table 2: Diameter required according to permitted load losses. Below, actual load losses with commercial diameter. (Own elaboration)

hf (mca) allowed	Q (L / h)	L (m)	Leq (m)	Sg / Sr	F	D (mm) calculated
2.25	500	100	0.88	0.4	0.37	20.93
0.75	7750	25	0.5	1.6	0.40	38.51

D (mm) commercial	Q (L / h)	L (m)	Leq (m)	S g / Sr	F	hf (mca) calculated
twenty	500	100	0.88	0.4	0.37	2.79
fifty	7750	25	0.5	1.6	0.40	0.24
					TOTAL	3,027

It has been chosen a branch with a smaller diameter to the detriment of a portaramales with a greater diameter since many more meters of branch must be acquired than portaramales, reason why in saving investment costs.

2.1.4.2.2. Primary, secondary and suction pipeline

As in the previous case, the Blasius equation is used to determine the load losses in the studied sections. In this case, up to 3mca can be dissipated, of which 2 will be lost in the primary pipe, 0.5 in the secondary pipe and 0.5 in the suction pipe.

In this way, as in the previous case, the diameters are obtained as a function of the permitted load losses, and then a commercial diameter is selected and the load losses recalculated. As a pipe without outlets, the reduction factor F, nor the equivalent length due to drippers or 90 ° turns, is not applied. Therefore, the Blasius equation is as follows:

$$D(mm) = \sqrt[4,75]{0,465 \times \frac{Q_{(l/h)}^{1,75} \times L_{(m)}}{hf_{(m)}}}$$

The following table shows the obtained diameters, the chosen commercial diameters and the losses of load with those diameters.

Table 3: Diameter required according to permitted load losses. Below, actual load losses with commercial diameter. (Own elaboration)

hf (m) allowed	Q (L / h)	L (m)	D (mm) calculated
0.5	15500	120	94.38
0.5	15500	200	105.10
2	15500	750	103.68

D (mm) commercial	Q (L / h)	L (m)	hf (m) calculated
110	15500	120	0.24
90	15500	200	1.04
110	15500	750	1.51
		TOTAL	2.80

2.2. Summary table

Below is a summary in tabular form where you can see the chosen commercial diameters, flow rates, lengths, load losses in pipelines and single points, reduction factors, and water pump data and pressure Operation of the drippers:

Table 4: Diameters, lengths, flows, and load losses per sections. (Own elaboration)

Branch						
D (mm) commercial	Q (L / h)	L (m)	Leq (m) droppers	Sg	F	hf (mca) calculated
twenty	500	100	0.88	0.4	0.37	2.79

Portaramal						
D (mm) commercial	Q (L / h)	L (m)	Leq (m) branches	Mr	F	hf (m) calculated
fifty	7750	25	0.5	1.6	0.40	0.24

Primary			
D (mm) commercial	Q (L / h)	L (m)	hf (mca) calculated
110	15500	750	1.51

High school			
D (mm) commercial	Q (L / h)	L (m)	hf (mca) calculated
90	15500	200	1.04

Succi ng			
D (mm) commercial	Q (L / h)	L (m)	hf (mca) calculated
110	15500	120	0.24

ng connection			
D (mm) commercial	Q (L / h)	L (m)	hf (mca) calculated
63	15500	0.2	0,0057

Singular points				
Kind	Deq (mm)	Q (L / h)	Leq (m)	hf (mca) calculated
Elbows 90 ° Pipe 100 mm	110	15500	3.1	0.01
Elbows 90 ° in pipes of 63 mm	63	15500	1.8	0.04
Elbows 90 ° Pipe 20 mm	20	500	0.9	0.00
T-bend	50	15500	1.8	1.28
Stopcocks	63	15500	0.6	0.01
Filters	110	15500	5	0.01
			Total	1.35

Table 5: Total losses of loads in hydraulic circuit. (Own elaboration)

	Height pressure (mca)
Total hydraulic circuit	**7.18**

Table 6: Pressures in first and last drippers. (Own elaboration)

	Height pressure (mca)
Pressure water pump	30
Difference of total heights	eleven
dropper pressure	eleven
Total hf until the last dropper	7.18
Pressure last dropper	30-11-7.18 = 11.82
Pressure first dropper	30- 6-2 = 22

As you can see, the pressure head reaching the last dropper is 11.82mca so the circuit has a margin of 0.82mca. On the other hand, in the nearest dropper the pressure height is 22mca, below the 40mca that has the upper limit.

ANNEX 6: FINANCIAL EVALUATION OF THE PROJECT

Sebastián Sangro Lucas

INDEX

1. INTRODUCTION

The financial evaluation of the project does not help determine the profitability of an investment through collections and payments over the life of the project. In this way, it is possible to know if the investment is profitable before carrying it out and thus avoid losses, besides posing several critical scenarios, essential in the decision making during the exploitation of the project. Cash flows, collections and payments do not take into account amortization or loss of opportunities.

2. INVESTMENT PARAMETERS

2.1. Investment Payment (k)

The payment of the investment k is the initial disbursement that must be made for the start up of the project. In this case the investment is made in three years, year 0 k_0 = 84 107.55 €, Year 1 k_1 = € 76,607.55 per year 2k_2 = € 76,607.55.

2.2. Project useful life

The life of this project is determined by the life of the most expensive installation, the irrigation system which has an average durability of 20 years. Although irrigation installed in year 2 could be used up to the year 22, the project lifetime ends in year 20 as the facilities of years 1 and 2 can not operate without facilities of the year 0.

2.3. Cash flows

For the calculation of cash flows, ordinary and extraordinary charges are determined on the one hand, and ordinary and extraordinary payments on the other.

Charges are all income earned and payments represent disbursements made.

Ordinary receipts are those revenues obtained from the sale of horticultural products harvested on the farm and from subsidies, if any.

Extra charges are the proceeds from the sale of used machinery and loans if any.

Ordinary payments are those derived from farm operations, labor, raw materials, energy and others.

The extraordinary payments are those derived from the renewal of materials or machinery and from the annuities of the loans if any.

2.3.1. Ordinary Payments

The following table shows all the elements involved in the production process. Payments are shown per year throughout the life of the project.

Tabla 1: Ordinary payments over the life of the project. (Own elaboration)

ORDINARY PAYMENTS									
Year	Workforce		Gasoil		Others		Surface	Total regular payments	
	€ / ha	Br / ha	€ / ha	Br / ha	€ / ha	Br / ha	he has	€ / year	Br / year
0	3383.33	81200.00	458.33	11,000.00	125.00	3000.00	5.00	19833.33	476000.00
1	2975.00	71400.00	458.33	11,000.00	125.00	3000.00	10.00	35583.33	854000.00
2	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
3	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
4	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
5	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
6	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
7	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
8	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
9	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
10	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
11	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
12	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
13	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
14	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
15	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
16	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
17	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
18	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
19	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00
20	2838.89	68133.33	458.33	11,000.00	125.00	3000.00	15.00	51333.33	1232000.00

The workforce includes 11 wages of 2000 Birr for every 5 hectares corresponding to workers and guards, and a salary of 3,000 Birr

and another of 4,000 for the whole estate corresponding to the teacher and the foreman.

In others, insurance and tax payments are included for the land.

2.3.2. Extraordinary Payments

Extraordinary payments include the renewal of hand tools, estimated at 3000 Birr and with a life of 5 years, and the renewal of the motor pump, which has a price of 550 euros and a useful life of 8 years.

Tabla 2: Extraordinary payments over the life of the project. (Own elaboration)

Year	Total extraordinary payments	
	€ / year	Br / g lis
0	0.00	0
1	0.00	0
2	0.00	0
3	0.00	0
4	125.00	3000
5	0.00	0
6	0.00	0
7	550.00	13200
8	0.00	0
9	125.00	3000
10	0.00	0
11	0.00	0
12	0.00	0
13	0.00	0
14	125.00	3000
15	550.00	13200
16	0.00	0
17	0.00	0
18	0.00	0
19	125.00	3000
20	0.00	0

2.3.3. Ordinary collections

Ordinary receipts correspond, on the one hand, to the savings of not buying a large part of the students' food in the market, and on the other hand, through the sale of surpluses. The average price of the product is 7 Birr / kg (0.29 € / kg) and the average yield of the farm is around 21 tonnes per hectare per year.

Tabla 3: Ordinary collections over the life of the project. (Own elaboration)

Year	ORDINARY CHARGES					
	Production on Media	Half price		Surface	Total ordinary charges	
	Kg / ha	€ / kg	Br / kg	he has	€ / year	Br / g lis
0	0	0.29	7.00	5	0	0
1	21000	0.29	7.00	10	30625.00	735000
2	21000	0.29	7.00	15	61250.00	1470000
3	21000	0.29	7.00	15	91875.00	2205000
4	21000	0.29	7.00	15	91875.00	2205000
5	21000	0.29	7.00	15	91875.00	2205000
6	21000	0.29	7.00	15	91875.00	2205000
7	21000	0.29	7.00	15	91875.00	2205000
8	21000	0.29	7.00	15	91875.00	2205000
9	21000	0.29	7.00	15	91875.00	2205000
10	21000	0.29	7.00	15	91875.00	2205000
11	21000	0.29	7.00	15	91875.00	2205000
12	21000	0.29	7.00	15	91875.00	2205000
13	21000	0.29	7.00	15	91875.00	2205000
14	21000	0.29	7.00	15	91875.00	2205000
15	21000	0.29	7.00	15	91875.00	2205000
16	21000	0.29	7.00	15	91875.00	2205000
17	21000	0.29	7.00	15	91875.00	2205000
18	21000	0.29	7.00	15	91875.00	2205000
19	21000	0.29	7.00	15	91875.00	2205000
20	21000	0.29	7.00	15	91875.00	2205000

2.3.4. Extra collections

There are no extraordinary collections over the life of the project.

2.3.5. Cash flows

The cash flows are shown in the following table:

Tabla 4: Cashflows over the life of the project. (Own elaboration)

	K		Collections				Payments				Cash flow	
			Ordinary		Extraordinary		Ordinary		Extraordinary			
Year	€	Br	€	Br	€	Br	€	Br	€	Br	€	Br
0	84107,55	2018581,2	0	0	0	0	19833.33	476000	0	0	-103940.88	-2494581
1	76607,55	1838581,2	30625	735000	0.00	0	35583.33	854000	0.00	0	-81565.88	-1957581
2	76607,55	1838581,2	61250	1470000	0.00	0	51333.33	1232000	0.00	0	-66690.88	-1600581
3	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
4	-	-	91875	2205000	0.00	0	51333.33	1232000	125.00	3000	40416.67	970000
5	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
6	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
7	-	-	91875	2205000	0.00	0	51333.33	1232000	550.00	13200	39991.67	959800
8	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541,67	973000
9	-	-	91875	2205000	0.00	0	51333.33	1232000	125.00	3000	40416.67	970000
10	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
11	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
12	-	-	91875	2205000	0.00	0	51333.33	1232,000	0.00	0	40541.67	973000
13	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
14	-	-	91875	2205000	0.00	0	51333.33	1232000	125.00	3000	40416.67	970000
15	-	-	91875	2205000	0.00	0	51333.33	1232000	550.00	13200	39991.67	959800
16	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
17	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
18	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000
19	-	-	91875	2205000	0.00	0	51333.33	1232000	125.00	3000	40416.67	970000
20	-	-	91875	2205000	0.00	0	51333.33	1232000	0.00	0	40541.67	973000

3. PROFITABILITY CRITERIA

3.1. Net Present Value (NPV)

The NPV is defined as the total gain of the project generated over the life of the project and its absolute profitability. A NPV greater than zero indicates that there will be gains throughout the project, while a NPV below zero means that money is lost over the life of the project as a whole.
For the calculation of the NPV the following expression is used:

$$NPV = -\sum_{i=0}^{n} \frac{K_i}{(1+r)^i} + \sum_{i=1}^{n} \frac{R_i}{(1+r)^i}$$

With:

K = initial investment in €.
R $_i$ = cash flow in year i, in €.
N = project lifetime in years.
I = project year number
R = interest rate. An interest rate of 3% is assumed.

A NPV of € 278,427.7 was obtained.

3.2. Investment benefit ratio

The B / I ratio is the current gain obtained by each monetary unit invested in the project. It is calculated from the following formula:

$$IBR = \frac{VAN}{\sum_{i=0}^{n} \frac{K_i}{(1+r)^i}}$$

The investment is viable while the IBR is greater than zero. In this case, you get an RBI of 1.2 €. That is to say that for each euro invested that euro is obtained, and another 1.2 € extra.

3.3. Internal Rate of Return

It is the update rate for which the NPV equals zero. An investment is viable if your IRR is higher than the interest rate.
It is obtained by the following equation:

$$VAN = 0 = -\sum_{i=0}^{n} \frac{K_i}{(1+\lambda)^i} + \sum_{i=1}^{n} \frac{R_i}{(1+\lambda)^i}$$

The investment is viable while. In this case, so that the investment is viable and is far from being affected by a reasonable increase in the discount rate.

3.4. Pay back or recovery period

It is defined as the moment or time when the investment is recovered. From that moment, the sum of the cash flows up to year is greater than zero. It is calculated by the following expression:

$$\sum_{i=1}^{n} \frac{R_i}{(1+r)^i} \geq \sum_{i=0}^{n} \frac{K_i}{(1+r)^i}$$

The period of recovery of the investment is 9.23 years.

3.5. Summary of project profitability

The following table summarizes the profitability data of the project and, as you can see, the project is viable.

Tabla 5: Summary of profitability. (Own elaboration)

Criterion	Value
NET PRESENT VALUE	278 427.75
RATIO BENEFIT INVESTMENT	1.21
INTERNAL PERFORMANCE RATE	12%
RECOVERY PERIOD	Year 9.2

DOCUMENT 3: BUDGET

Sebastián Sangro Lucas

1. MEASUREMENTS

MEASUREMENTS			
Chapter 1	TREE CUT AND ROCK REMOVAL		
Order number	Unite	Item description	Quantity
1.1	Ha (Hectare)	**FELLING LARGE TREES WITH HELP OF MACHINERY.** Tree cut of trees of more than 4 meters with mechanical means and transport of the wood.	15
1.2	Ha	**MANUAL LOGGING small trees.** Tree cut de Trees of less than 4 meters with manual means and transport of the wood.	15
1.3	Ha	**LAND MANUAL DISMISSED.** Manual clearing of land with moldboard pass.	15
Chapter 2:	EARTH MOVEMENTS		
Order number	Unite	Item description	Quantity
2	Meters	**DITCH EXCAVATION IN GROUND AND FILLING.** Excavation in trench in loose terrain with manual means, without load or transport to landfill and later filling of ditch.	1820
Chapter 3:	PIPELINES		
Subchapter 3.1:	SUCTION PIPING		
Order number	Unite	Item description	Quantity
3.1.1	Meters	**PIPE PVC NP6, ND = 110 mm.** PVC pipe of 110mm nominal diameter, elastic joint, for a pressure of Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	120
3.1.2	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for pressure Work of 6 kg / cm2.	5
3.1.3	Meters	**NP6 PVC pipe, ND = 63 mm** PVC pipe nominal diameter 63mm, insert joint, for pressure Work of 6 kg / cm2.	5
3.1.3	Unite	**PVC ELBOW GLUED JOINT 90º FF NP6, ND = 110 mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	1
3.1.4	Unite	**PVC CODE GLUED JOINT 90º FF NP6, ND = 63mm.** 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, of 63mm diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	1
3.1.5	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm.** PVC reducing bush with bonded type glass for elbow parts 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	1

3.1.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm.** PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	1
Subchapter 3.2:	SECONDARY PIPING		
Order number	Unite	Item description	Quantity
3.2.1	Meters	**NP6 PVC pipe, ND = 90 mm** PVC pipe nominal diameter 90mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	210
3.2.2	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for pressure Work of 6 kg / cm2.	5
3.2.3	Unite	**PVC ELBOW GLUED JOINT 90º FF NP6, ND = 90mm.** 90º female-female elbow of PVC, with glued joint for a working pressure of 6 kg / cm2, of 90mm of diameter placed in PVC pipe of water supply, including joints, not including anchors, completely installed.	2
3.2.4	Unite	**PVC ELBOW GLUED JOINT 90º FF NP6, ND = 110mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	1
3.2.5	Unite	**PVC Unite GLUED JOINT 90, ND = 110mm** PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	1
3.2.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 90/50 mm.** PVC reducer with glue-type glass for elbow parts 90 / 50mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	1
3.2.7	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/90 mm.** PVC reducing bush with glued joint of type glass for elbow pieces of 110 / 90mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	2
Subchapter 3.3:	PRIMARY PIPELINE		
Order number	Unite	Item description	Quantity
3.3.1	Meters	**NP6 PVC pipe, ND = 110 mm** PVC pipe nominal diameter 110mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	1515
3.3.2	Meters	**NP6 PVC pipe, ND = 63 mm** PVC pipe nominal diameter 63mm, insert joint, for pressure Work of 6 kg / cm2.	15
3.3.3	Unite	**PVC Unite GLUED JOINT 90, ND = 110mm** PVC Te 90 with bonded joint, 110 mm in diameter, placed in	30

		PVC pipe water supply, i / boards, not including since anchoring, fully installed.	
3.3.4	Unite	**PVC Unite GLUED JOINT 90, ND = 63mm** PVC Te 90 with bonded joint, 63mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	30
3.3.5	Unite	**PVC ELBOW GLUED JOINT 90º FF NP6, ND = 110mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	30
3.3.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm.** PVC reducing bush with bonded type glass for elbow pieces 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	30
3.3.7	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm.** PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	60
3.3.8	Unite	**STOPCOCK. ND = 63 mm.** PVC closure wrench of 63mm diameter glued joint, placed in PVC water supply pipe, including joints fully installed.	30
Subchapter 3.4:	PORTA PIPELINE BRANCHES		
Order number	Unite	Item description	Quantity
3.4.1	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for pressure Work of 6 kg / cm2.	1440
3.4.2	Unite	**PVC Unite GLUED JOINT 90, ND = 50mm** PVC Te 90 with bonded joint, 50mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	870
3.4.3	Unite	**PVC ELBOW GLUED JOINT 90º FF NP6, ND = 50mm.** 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, 50mm diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	60
3.4.4	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 50/20 mm.** PVC reducer bushing with glue-type gasket for elbow parts of 50 / 20mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	930
Subcapítu 3.5:	RAMALES DOOR GOTEROS		
Order number	Unite	Item description	Quantity
3.5.1	Meters	**FLEXIBLE PIPING PE NP6 PORTAGOTEROS, ND = 20 mm** PE pipe Flexible portagoteros nominal diameter 20mm, insert joint, for a working pressure of 6 kg / cm2.	93000
3.5.2	Unite	**GOTERO BUTTON WITH PRESSURE COMPENSATED 2l /F1-4bar.** Drippers of	232500

		compensated button type, flow rate 2l /Fand operating pressure between 1 and 4 bars.	
3.5.3	Unite	**CONNECTION GRADED IN X FOUR OUTPUTS 16mm.** 3/4 "female toothed connection in four outlets for 3/5" male type tif drippers.	232500
3.5.4	Meters	**FLEXIBLE PIPING PE NP6, ND = 16mm** flexible pipe nominal diameter 16mm, insert joint, for a working pressure of 6 kg / cm2 PE.	251100
3.5.5	Unite	**STAIN GUIDE FOR PE PIPES, ND = 16MM.** Simple stabilizing guide stake for ND = 16mm PE pipes installed and nailed to the floor	930000
3.5.6	Unite	**PLUG F glued ND 20 mm.** Female plug, PVC-6 atm bonding, 20 mm nominal diameter, for the drains of the branches, fully placed and tested	930
Chapter 4:	CASITA PUMPKIN		
Order number	Unite	Item description	Quantity
4	Unite	**POT CASE OF 4x5m AND HEIGHT OF 2 m.** Castea to house the bomb of 4x5m and height of 2 m, with reinforced concrete floor HN-20 of 15cm of thickness, reinforced concrete walls of the same characteristics that the solera of 10 cm of thickness and cover of fiber cement covered cloth Asphalt 3mm thick for waterproofing the structure, completely assembled and installed.	1
Chapter 5:	WATER PUMP		
Order number	Unite	Item description	Quantity
5	Unite	**WATER PUMP CANTABRIAN Genergy 35000l / h, 36mca.** Water pump genergy Cantabrian model, 52x43x60 and 30kg, maximum flow 35000l / h, and maximum pressure head 36mca, engine GENERGY SG70 2CV, 4 stroke air-cooled, 7.7L gasoline.	1

2. PRICE TABLE NO.1

TABLE OF PRICES 1				
Chapter 1 :	TREE CUT AND ROCK REMOVAL			
Order number	Unite	Item description	€ / ud.	Br / u.
1.1	hectares	**FELLING LARGE TREES WITH HELP OF MACHINERY** .Tree cut of trees more than 4 meters with mechanical means and timber transportation.	€ 100.00	2.400,00Br
1.2	hectares	**MANUAL LOGGING small trees.** Tree cut de Trees of less than 4 meters with manual means and transport of the wood.	€ 133.00	3.192,00Br
1.3	hectares	**LAND MANUAL DISMISSED.** Manual clearing of land with moldboard pass.	€ 100.00	2.400,00Br
Chapter 2:	EARTH MOVEMENTS			
Order number	Unite	Item description	€ / ud.	Br / u.
2	Meters	**DITCH EXCAVATION IN GROUND AND FILLING.** Excavation in trench in loose terrain with manual means, without load or transport to landfill and later filling of ditch.	€ 0.08	1,92Br
Chapter 3:	PIPELINES			
Subchapter 3.1:	SUCTION PIPING			
Order number	Unite	Item description	€ / ud.	Br / u.
3.1.1	Meters	**NP6 PVC pipe, ND = 110 mm** PVC pipe nominal diameter 110mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	$ 3.69	88,56Br
3.1.2	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 0.70	16,80Br
3.1.3	Meters	**NP6 PVC pipe, ND = 63 mm** PVC pipe nominal diameter 63mm, insert joint, for a working pressure of 6 kg / cm2.	$ 2.04	48,96Br
3.1.4	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110 mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
3.1.5	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 63mm.** 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, of 63mm of diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 1.71	41.04Br
3.1.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm.** PVC reducing bush with bonded type glass for elbow parts 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.74	41.76Br
3.1.7	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm.** PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter,	€ 0.89	21,36Br

		placed in PVC elbow of water supply, including joints without anchoring.		
Subchapter 3.2:	SECONDARY PIPING			
Order number	Unite	Item description	€ / ud.	Br / u.
3.2.1	Meters	**NP6 PVC pipe, ND = 90 mm** PVC pipe nominal diameter 90mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	€ 3.26	78,24Br
3.2.2	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 0.70	16,80Br
3.2.3	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 90mm.** 90º female-female elbow of PVC, with glued joint for a working pressure of 6 kg / cm2, of 90mm of diameter placed in PVC pipe of water supply, including joints, not including anchors, completely installed.	€ 6.62	158.88Br
3.2.4	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
3.2.5	Unite	**PVC Unite GLUED JOINT 90, ND = 110mm** PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	9,68 €	232.32Br
3.2.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 90/50 mm.** PVC reducer with glue-type glass for elbow parts 90 / 50mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.27	30.48Br
3.2.7	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/90 mm.** PVC reducing bush with glued joint of type glass for elbow pieces of 110 / 90mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 2.91	69.84Br
Subchapter 3.3:	PRIMARY PIPELINE			
Order number	Unite	Item description	€ / ud.	Br / u.
3.3.1	Meters	**NP6 PVC pipe, ND = 110 mm** PVC pipe nominal diameter 110mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	$ 3.69	88,56Br
3.3.2	Meters	**NP6 PVC pipe, ND = 63 mm** PVC pipe nominal diameter 63mm, insert joint, for a working pressure of 6 kg / cm2.	$ 2.04	48,96Br
3.3.3	Unite	**PVC Unite GLUED JOINT 90, ND = 110mm** PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	9,68 €	232.32Br
3.3.4	Unite	**PVC Unite GLUED JOINT 90, ND = 63mm** PVC Te 90 with bonded joint, 63mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 1.71	41.04Br

3.3.5	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110mm.** 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
3.3.6	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm.** PVC reducing bush with bonded type glass for elbow parts 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.74	41.76Br
3.3.7	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm.** PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 0.89	21,36Br
3.3.8	Unite	**STOPCOCK. ND = 63 mm.** PVC closure wrench of 63mm diameter glued joint, placed in PVC water supply pipe, including joints fully installed.	€ 11.76	282.24 Br
Subchapter 3.4:	PORTA PIPELINE BRANCHES			
Order number	Unite	Item description	€ / ud.	Br / u.
3.4.1	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 0.70	16,80Br
3.4.2	Unite	**PVC Unite GLUED JOINT 90, ND = 50mm** PVC Te 90 with bonded joint, 50mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 1.20	28.80Br
3.4.3	Unite	**PVC ELBOW 90º FF GLUED JOINT NP6, ND = 50mm.** 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, 50mm diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 1.20	28.80Br
3.4.4	Unite	**REDUCCT CAP. VESSEL TYPE PVC ND = 50/20 mm.** PVC reducer bushing with glue-type seal for elbow pieces of 50 / 20mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 0.37	8,88Br
Subcapítu 3.5:	RAMALES DOOR GOTEROS			
Order number	Unite	Item description	€ / ud.	Br / u.
3.5.1	Meters	**FLEXIBLE PIPING PE NP6, ND = 20 mm** PE pipe flexible 20mm nominal diameter, insert joint, for a working pressure of 6 kg / cm2.	€ 0.28	6,72Br
3.5.2	Unite	**GOTERO BUTTON WITH PRESSURE COMPENSATED 2l /F1-4bar.** Drippers of compensated button type, flow rate 2l /Fand operating pressure between 1 and 4 bars.	€ 0.21	5.04Br
3.5.3	Unite	**CONNECTION GRADED IN X FOUR OUTPUTS 16mm.** 3/4 "female toothed connection in four outlets for 3/5" male type tif drippers.	€ 0.09	2.16Br
3.5.4	Unite	**FLEXIBLE PIPING PE NP6, ND = 16mm** flexible pipe nominal diameter 16mm, insert joint, for a working pressure of 6 kg / cm2 PE.	€ 0.20	4.80Br
3.5.5	Unite	**STAIN GUIDE FOR PE PIPES, ND = 16mm.**	€ 0.20	4.80Br

		Simple stabilizing guide stake for ND = 16mm PE pipes installed and nailed to the ground		
3.5.6	Meters	**STOPPERFglueing ND 20 mm.** Female plug, PVC-6 atm bonding, 20 mm nominal diameter, for the drains of the branches, fully placed and tested	€ 0.16	3,84Br
Chapter 4:	CASITA PUMPKIN			
Order number	Unite	Item description	€ / ud.	Br / u.
4	Unite	**POT CASE OF 4x5m AND HEIGHT OF 2 m.** Castea to house the pump of 4x5m and height of 2 m, with reinforced concrete floor HN-20 of 15cm of thickness, walls of reinforced concrete of the same characteristics as the hearth of 10 cm of thickness and cover of fiber cement covered cloth Asphalt 3mm thick for waterproofing the structure, completely assembled and installed.	€ 5,000.00	120,000.00Br
Chapter 5:	WATER PUMP			
Order number	Unite	Item description	€ / ud.	Br / u.
5	Unite	**WATER PUMP CANTABRIAN Genergy 35000l / h, 36mca.** Water pump genergy model Cantabrian model, 52x43x60 and 30kg, maximum flow 35000l / h, and maximum pressure height 36mca, engine GENERGY SG70 2CV, 4 stroke air-cooled, 7.7L gasoline.	€ 550.00	13,200.00Br

3. PRICE TABLE No. 2

TABLE OF PRICES 2				
Chapter 1:	TREE CUT AND ROCK REMOVAL			
Order number	Unite	Item description	€ / ud.	Br / u.
1.1	Ha (Hectare)	**FELLING LARGE TREES WITH HELP OF MACHINERY** .Tree cut of trees more than 4 meters with mechanical means and timber transportation.	€ 100.00	2.400,00Br
		Machinery	€ 40.00	960,00Br
		Workforce	€ 30.00	720,00Br
		Gasoline	€ 27.00	648,00Br
		3% Indirect costs	€ 3.00	72.00Br
1.2	Ha	**MANUAL LOGGING small trees.** Tree cut de Trees of less than 4 meters with manual means and transport of the wood.	€ 133.00	3.192,00Br
		Workforce	€ 120.00	2.880,00Br
		materials	€ 13.00	312,00Br
1.3	Ha	**LAND MANUAL DISMISSED.** Manual clearing of land with moldboard pass.	€ 100.00	2.400,00Br
		Workforce	€ 95.00	2.280,00Br
		materials	€ 5.00	120.00Br
Chapter 2:	EARTH MOVEMENTS			
Order number	Unite	Item description	€ / ud.	Br / u.
2	Meters	**DITCH EXCAVATION IN GROUND AND FILLING.** Excavation in trench in loose terrain with manual means, without load or transport to landfill and later filling of ditch.	€ 0.08	1,92Br
		Workforce	€ 0.07	1,68Br
		materials	$ 0.01	0.24Br
Chapter 3:	PIPELINES			
Subchapter 3.1:	SUCTION PIPING			
Order number	Unite	Item description	€ / ud.	Br / u.
3.1.1	Meters	**NP6 PVC pipe, ND = 110 mm** PVC pipe nominal diameter 110mm, insert joint, for pressure Work of 6 kg / cm2, placed in ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.	$ 3.69	88,56Br
		Tub.PVC smooth elastic joint NP6 ND = 110mm	€ 3.13	75,12Br
		Ordinary pawn	€ 0.37	8,88Br
		PVC pipe cleaner	€ 0.01	0.17Br
		Gasket grease	€ 0.18	4,32Br
3.1.2	Meters	**NP6 PVC pipe, ND = 50 mm** PVC pipe nominal diameter 50mm, insert joint, for pressure Work of 6 kg / cm2.	€ 0.70	16,80Br
		Tub.PVC smooth elastic joint NP6 ND = 50mm	€ 0.63	15,12Br
		Ordinary pawn	€ 0.07	1,68Br
		PVC pipe cleaner	€ 0.001	0.02Br
		Gasket grease	€ 0.04	0.84Br
3.1.3	Meters	**NP6 PVC pipe, ND = 63 mm** PVC pipe nominal diameter 63mm, insert joint, for pressure Work of 6 kg / cm2.	$ 2.04	48,96Br

		Elastic joint pipelinePVC ND = 63 mm	€ 1.83	43,92Br
		Ordinary pawn	€ 0.20	4.80Br
		PVC pipe cleaner	€ 0.004	0.10Br
		Gasket grease	0.10 €	2,40Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110 mm. 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
		PVC elbow 90 glued joint. FF NP6, ND = 110mm	€ 6.60	158,40Br
		Ordinary pawn	€ 0.78	18.72Br
3.1.4	Unite	PVC Adhesives Glued joint	€ 0.39	9,31Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 63mm. 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, of 63mm diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 1.71	41,04Br
		PVC elbow 90 glued joint. FF NP6, ND = 63mm	€ 1.45	34.80Br
		Ordinary pawn	€ 0.17	4.08Br
3.1.5	Unite	PVC Adhesives Glued joint	€ 0.09	2.06Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm. PVC reducing bush with bonded type glass for elbow parts 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.74	41.76Br
		PVC glued joint. MF NP6, ND = 110 / 63mm	€ 1.48	35,52Br
		Ordinary pawn	€ 0.17	4.08Br
3.1.6	Unite	PVC Adhesives Glued joint	€ 0.09	2.06Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm. PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 0.89	21,36Br
		PVC glued joint. MF NP6, ND = 63 / 50mm	0.78	18.72Br
		Ordinary pawn	0.1	2,40Br
3.1.7	Unite	PVC Adhesives Glued joint	0.01	0.24Br
Subchapter 3.2:	SECONDARY PIPING			
Order number	Unite	Item description	€ / ud.	Br / u.
		PVC pipe NP6, ND = 90 mm PVC pipe 90mm nominal diameter, insert joint, for a working pressure of 6 kg / cm2, placed in a trench on the ground directly c / pp aids, excluding Excavation and subsequent filling of the trench.	€ 3.26	78,24Br
		Tub.PVC smooth elastic joint NP6 ND = 90mm	€ 2.93	70,32Br
		Ordinary pawn	€ 0.33	7,92Br
		PVC pipe cleaner	€ 0.01	0.17Br
3.2.1	Meters	Gasket grease	0.16	3,84Br
		NP6 PVC pipe, ND = 50 mm PVC pipe nominal diameter 50mm, insert joint, for pressure Work of 6 kg / cm2.	€ 0.70	16,80Br
3.2.2	Meters			

		Tub.PVC smooth elastic joint NP6 ND = 50mm	€ 0.63	15,12Br
		Ordinary pawn	€ 0.07	1,68Br
		PVC pipe cleaner	€ 0.001	0.02Br
		Gasket grease	€ 0.04	0.84Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 90mm. 90º female-female elbow of PVC, with glued joint for a working pressure of 6 kg / cm2, of 90mm of diameter placed in PVC pipe of water supply, including joints, not including anchors, completely installed.	€ 6.62	158.88Br
		PVC elbow 90 glued joint. FF NP6, ND = 90mm	€ 5.62	134.88Br
		Ordinary pawn	€ 0.66	15,84Br
3.2.3	Unite	PVC Adhesives Glued joint	€ 0.33	7,94Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110mm. 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
		PVC elbow 90 glued joint. FF NP6, ND = 110mm	€ 6.60	158,40Br
		Ordinary pawn	€ 0.78	18.72Br
3.2.4	Unite	PVC Adhesives Glued joint	€ 0.39	9,31Br
		PVC Unite GLUED JOINT 90, ND = 110mm PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	9,68 €	232.32Br
		Unite glued joint PVC 90a. FF NP6, ND = 110mm	€ 8.23	197.52 Br
		Ordinary pawn	€ 0.97	23.28Br
3.2.5	Unite	PVC Adhesives Glued joint	€ 0.48	11.62Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 90/50 mm. PVC reducer with glue-type glass for elbow parts 90 / 50mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.27	30.48Br
		PVC glued joint. MF NP6, ND = 90 / 50mm	€ 1.09	26,16Br
		Ordinary pawn	€ 0.17	4.08Br
3.2.6	Unite	PVC Adhesives Glued joint	€ 0.01	0.24Br
		CAP REDUCCT. VESSEL TYPE PVC ND = 110/90 mm. PVC reducing bush with glued joint of type glass for elbow pieces of 110 / 90mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 2.91	69.84Br
		PVC glued joint. MF NP6, ND = 110 / 90mm	€ 2.56	61.44Br
		Ordinary pawn	€ 0.29	6,96Br
3.2.7	Unite	PVC Adhesives Glued joint	€ 0.06	1.39Br
Subcapí title 3.3:	PRIMARY PIPELINE			
Order number	Unite	Item description	€ / ud.	Br / u.
		NP6 PVC pipe, ND = 110 mm PVC pipe nominal diameter 110mm, insert joint, for pressure Work of 6 kg / cm2, placed in		
3.3.1	Meters		$ 3.69	88,56Br

		ditch on the ground directly w / pp of auxiliary means, without including excavation and later filling of the trench.		
		Tub.PVC smooth elastic joint NP6 ND = 110mm	€ 3.13	75,12Br
		Ordinary pawn	€ 0.37	8,88Br
		PVC pipe cleaner	€ 0.01	0.17Br
		Gasket grease	€ 0.18	4,32Br
		NP6 PVC pipe, ND = 63 mm PVC pipe nominal diameter 63mm, insert joint, for pressure Work of 6 kg / cm2.	$ 2.04	48,96Br
		Elastic joint pipelinePVC ND = 63 mm	€ 1.83	43,92Br
		Ordinary pawn	€ 0.20	4.80Br
		PVC pipe cleaner	€ 0.004	0.10Br
3.3.2	Meters	Gasket grease	0.10 €	2,40Br
		PVC Unite GLUED JOINT 90, ND = 110mm PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	9,68 €	232.32Br
		Unite glued joint PVC 90a. FF NP6, ND = 110mm	€ 8.23	197.52 Br
		Ordinary pawn	€ 0.97	23.28Br
3.3.3	Unite	PVC Adhesives Glued joint	€ 0.48	11.62Br
		PVC Unite GLUED JOINT 90, ND = 63mm PVC Te 90 with bonded joint, 63mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 1.71	41.04Br
		Unite glued joint PVC 90a. FF NP6, ND = 63mm	€ 1.45	34.80Br
		Ordinary pawn	€ 0.17	4.08Br
3.3.4	Unite	PVC Adhesives Glued joint	€ 0.09	2.06Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 110mm. 90 ° female-female elbow, with sealing joint for a working pressure of 6 kg / cm2, 110 mm in diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 7.77	186.48Br
		PVC elbow 90 glued joint. FF NP6, ND = 110mm	€ 6.60	158,40Br
		Ordinary pawn	€ 0.78	18.72Br
3.3.5	Unite	PVC Adhesives Glued joint	€ 0.39	9,31Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 110/63 mm. PVC reducing bush with bonded type glass for elbow parts 110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 1.74	41.76Br
		PVC glued joint. MF NP6, ND = 110 / 63mm	€ 1.48	35,52Br
		Ordinary pawn	€ 0.17	4.08Br
3.3.6	Unite	PVC Adhesives Glued joint	€ 0.09	2.06Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 63/50 mm. PVC reducer bushing with glue-type seal for elbow parts de110 / 63mm in diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 0.89	21,36Br
3.3.7	Unite			

		PVC glued joint. MF NP6, ND = 63 / 50mm	0.78	18.72Br
		Ordinary pawn	0.1	2,40Br
		PVC Adhesives Glued joint	0.01	0.24Br
		STOPCOCK. ND = 63 mm. PVC closure wrench of 63mm diameter glued joint, placed in PVC water supply pipe, including joints fully installed.	€ 11.76	282.24 Br
		PVC closure wrench, ND = 50 mm	€ 10.44	250,56Br
		Ordinary pawn	€ 0.88	21,12Br
3.3.8	Unite	PVC Cleaner	€ 0.44	10,51Br
Subcapí title 3.4:	PORTA PIPELINE BRANCHES			
Order number	Unite	Item description	€ / ud.	Br / u.
		NP6 PVC pipe, ND = 50 mm PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 0.70	16,80Br
		Tub.PVC smooth elastic joint NP6 ND = 50mm	€ 0.63	15,12Br
		Ordinary pawn	€ 0.07	1,68Br
		PVC pipe cleaner	€ 0.001	0.02Br
3.4.1	Meters	Gasket grease	€ 0.04	0.84Br
		PVC Unite GLUED JOINT 90, ND = 50mm PVC Te 90 with bonded joint, 50mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 1.20	28.80Br
		PVC 90 glued joint Unite FF NP6, ND = 50mm	€ 1.02	24.48Br
		Ordinary pawn	€ 0.12	2.88Br
3.4.2	Unite	PVC Adhesives Glued joint	€ 0.06	1,44Br
		PVC ELBOW 90º FF GLUED JOINT NP6, ND = 50mm. 90º female-female elbow, with adhesive bonded for a working pressure of 6 kg / cm2, 50mm diameter placed in PVC water supply pipe, including joints, not including anchors, fully installed.	€ 1.20	28.80Br
		PVC elbow 90 glued joint. FF NP6, ND = 50mm	€ 1.02	24.48Br
		Ordinary pawn	€ 0.12	2.88Br
3.4.3	Unite	PVC Adhesives Glued joint	€ 0.06	1,44Br
		REDUCCT CAP. VESSEL TYPE PVC ND = 50/20 mm. PVC reducer bushing with glue-type seal for elbow pieces of 50 / 20mm diameter, placed in PVC elbow of water supply, including joints without anchoring.	€ 0.37	8,88Br
		PVC glued joint. MF NP6, ND = 50 / 20mm	0.36	8,64Br
		Ordinary pawn	0.1	2,40Br
3.4.4	Unite	PVC Adhesives Glued joint	0.01	0.24Br
Subcapí title 3.5:	RAMALES DOOR GOTEROS			
Order number	Unite	Item description	€ / ud.	Br / u.
		FLEXIBLE PIPING PE NP6, ND = 20 mm PE pipe flexible 20mm nominal diameter, insert joint, for a working pressure of 6 kg / cm2.	€ 0.30	7,20Br
		Flexible plain NP tubing NP6 ND = 20mm	€ 0.28	6.72Br
		Ordinary pawn	€ 0.01	0.24Br
		PE pipe cleaner	€ 0.01	0.12Br
3.5.1	Meters	Gasket grease	€ 0.01	0.12Br

		GOTERO BUTTON WITH PRESSURE COMPENSATED 2l /F1-4bar. Drippers of compensated button type, flow rate 2l /Fand operating pressure between 1 and 4 bars.	€ 0.21	5.04Br
		Compensated button dropper 1-4bar and 2l / h	€ 0.20	4.70Br
		Ordinary pawn	€ 0.01	0.18Br
3.5.2	Unite	Perforator	€ 0.01	0.15Br
		CONNECTION GRADED IN X FOUR OUTPUTS 16mm. toothed female connection 3/4 "x four outputs for tif droppers button type 3/5" male.	€ 0.09	2,16Br
		toothed connection 4 outputs 3/4 "H	€ 0.08	2,02Br
		ordinary peon	€ 0.00	0,08Br
3.5.3	Unite	Grease board	€ 0.00	0,06Br
		FLEXIBLE PIPING PE NP6, ND = 16mm pipe flexible 16mm nominal diameter, insert joint, for a working pressure of 6 kg / cm2 PE.	€ 0.20	4,80Br
		Flexible pipe PE NP6, ND 16mm	€ 0.19	4,48Br
		ordinary peon	€ 0.01	0,18Br
		PE pipe cleaner	€ 0.00	0,07Br
3.5.4	Unite	Grease board	€ 0.00	0,07Br
		GUIDE TO STAKE PE PIPES, ND = 16mm. Stake single stabilizer guide for PE pipes ND = 16mm installed and downcast	€ 0.20	4,80Br
		Estaquilla simple guide for PE pipe ND = 16mm	€ 0.19	4,48Br
		ordinary peon	€ 0.01	0,18Br
3.5.5	Unite	Grease board	€ 0.01	0,14Br
		STOPPERFglueing ND = 20 mm. Female, PVC binding glue-6 atm, 20 mm nominal diameter to the drains of the branches, fully placed and tested plug	€ 0.16	3,84Br
		Plug female glueing ND = 20mm	€ 0.15	3,58Br
		ordinary peon	€ 0.01	0,14Br
3.5.6	meters	Grease board	€ 0.00	0,12Br
Chapter 4:	PUMPING SHED			
Order No.	Unite	Item description	€ / ud.	Br / ud.
		PUMPING SHED 4x5m and height of 2 m. Casts to house the pump 4x5m and height of 2 m, with a reinforced concrete HN-20 15cm thick reinforced concrete walls of the same characteristics as the solera of 10 cm thick and covered with fiber cement pimpled fabric cover 3 mm thick asphalt to waterproof the structure, fully assembled and installed.	5.000,00 €	120.000,00Br
		materials	4.100,00 €	98.400,00Br
		Workforce	900.00 €	21.600,00Br
4	Unite	Indirect costs 3%	150.00 €	3.600,00Br
Chapter 5:	WATER PUMP			
Order No.	Unite	Item description	€ / ud.	Br / ud.
		WATER PUMP CANTABRIAN Genergy 35000l / h, 36mca . Water Pump brand Genergy cantábrico model, 52x43x60 and 30kg, maximum flow 35000l / h, and the maximum air pressure 36mca, Genergy		
5	Unite		550.00 €	13.200,00Br

		SG70 2CV engine, 4 - stroke air - cooled gasoline 7,7L.		
		Cantabrica water pump Genergy 35000l / h	520.00 €	12.480,00Br
		ordinary peon	€ 13.50	324,00Br
		Indirect costs 3%	€ 16.50	396,00Br

4. PARTIAL BUDGET

PARTIAL BUDGET				
Chapter 1:	TREE CUT AND ROCK REMOVAL			
Order No.	Unite	Item description	€ / ud.	Br / ud.
1.1	ha (hectare)	FELLING LARGE TREES WITH HELP OF MACHINERY. Felling trees more than 4 meters with mechanical means and timber transportation.	1.500,00 €	36.000,00Br
1.2	Ha	MANUAL LOGGING OF SMALL TREES. Felling of trees less than 4 meters with manual means and timber transportation.	1.995,00 €	47.880,00Br
1.3	Ha	FIELD MANUAL rocking. Terrain rocking manual plowing.	1.500,00 €	36.000,00Br
		TOTAL CHAPTER 1	4.995,00 €	119.880,00Br
Chapter 2:	EARTHWORKS			
Order No.	Unite	Item description	€ / ud.	Br / ud.
2	meters	DITCH EXCAVATION IN GROUND AND FILLING. Trench excavation in loose terrain with manual means, without charge or transport to landfill and subsequent backfilling.	145.60 €	3.494,40Br
		TOTAL CHAPTER 2	145.60 €	3.494,40Br
Chapter 3:	PIPELINES			
Subcapí title 3.1:	PIPING SUCTION			
Order No.	Unite	Item description	€ / ud.	Br / ud.
3.1.1	meters	PVC pipe NP6, ND = 110 mm PVC pipe of 110mm nominal diameter, insert joint, to a pressure of work of 6 kg / cm2, placed in a trench on the ground directly c / pp aids, excluding excavation and backfill the trench.	442.80 €	10.627,20Br
3.1.2	meters	NP6 PVC pipe, ND = 50 mm PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 3.50	84,00Br
3.1.3	meters	NP6 PVC pipe, ND = 63 mm PVC pipe nominal diameter 63mm, insert joint, for a working pressure of 6 kg / cm2.	€ 10.20	244,80Br
3.1.4	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 110 mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 110 mm diameter PVC pipe placed in water supply, including joints, not including anchors, fully installed.	€ 7.77	186,48Br
3.1.5	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 63mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 63mm diameter PVC pipe placed in water supply, including	€ 1.71	41,04Br

		joints, not including anchors, fully installed.		
3.1.6	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 110/63 mm. Reducing bush PVC glass bonded joint elbow type for output parts 110 / 63mm diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	€ 1.74	41,76Br
3.1.7	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 63/50 mm. Reducing PVC cap with seal glued glass pieces elbow type for outputs of 110 / 63mm in diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	€ 0.89	21,36Br
		TOTAL Subchapter 3.1	468.61 €	11.246,64Br
Subcapí title 3.2:	PIPELINE OF SECONDARY			
Order No.	Unite	Item description	€ / ud.	Br / ud.
3.2.1	meters	PVC pipe NP6, ND = 90 mm PVC pipe 90mm nominal diameter, insert joint, to a pressure of work of 6 kg / cm2, placed in a trench on the ground directly c / pp aids, excluding excavation and backfill the trench.	684.60 €	16.430,40Br
3.2.2	meters	NP6 PVC pipe, ND = 50 mm PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	€ 3.50	84,00Br
3.2.3	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 90mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 90mm diameter PVC pipe placed in water supply, including joints, not including anchors, fully installed.	€ 13.24	317,76Br
3.2.4	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 110mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 110 mm diameter PVC pipe placed in water supply, including joints, not including anchors, fully installed.	€ 7.77	186,48Br
3.2.5	Unite	PVC Unite GLUED JOINT 90, ND = 110mm PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 9.68	232,32Br
3.2.6	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 90/50 mm. Reducing bush PVC glass bonded joint output type for elbow parts 90 / 50mm diameter, placed in PVC elbow water situation started, including	€ 1.27	30,48Br

		joints excluding the anchor.		
3.2.7	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 110/90 mm. Reducing bush PVC glass bonded joint elbow type for output parts 110 / 90mm diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	€ 5.82	139,68Br
		TOTAL Subchapter 3.2	725.88 €	17.421,12Br
Subcapí title 3.3:	PIPELINE OF PRIMARY			
Order No.	Unite	Item description	€ / ud.	Br / ud.
3.3.1	meters	PVC pipe NP6, ND = 110 mm PVC pipe of 110mm nominal diameter, insert joint, to a pressure of work of 6 kg / cm2, placed in a trench on the ground directly c / pp aids, excluding excavation and backfill the trench.	5.590,35 €	134.168,40Br
3.3.2	meters	NP6 PVC pipe, ND = 63 mm PVC pipe nominal diameter 63mm, insert joint, for a working pressure of 6 kg / cm2.	€ 30.60	734,40Br
3.3.3	Unite	PVC Unite GLUED JOINT 90, ND = 110mm PVC Te 90 with bonded joint, 110 mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	290.40 €	6.969,60Br
3.3.4	Unite	PVC Unite GLUED JOINT 90, ND = 63mm PVC Te 90 with bonded joint, 63mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	€ 51.30	1.231,20Br
3.3.5	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 110mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 110 mm diameter PVC pipe placed in water supply, including joints, not including anchors, fully installed.	233.10 €	5.594,40Br
3.3.6	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 110/63 mm. Reducing bush PVC glass bonded joint elbow type for output parts 110 / 63mm diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	€ 52.20	1.252,80Br
3.3.7	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 63/50 mm. Reducing PVC cap with seal glued glass pieces elbow type for outputs of 110 / 63mm in diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	€ 53.40	1.281,60Br
3.3.8	Unite	STOPCOCK. ND = 63 mm. Stopcock PVC 63mm diameter	352.80 €	8.467,20Br

		bonded joint, placed in PVC pipe water supply, including fully installed together.		
		TOTAL Subchapter 3.3	6.654,15 €	159.699,60Br
Subcapí title 3.4:	PIPELINE OF BRANCHES PORTA			
Order No.	Unite	Item description	€ / ud.	Br / ud.
3.4.1	meters	NP6 PVC pipe, ND = 50 mm PVC pipe nominal diameter 50mm, insert joint, for a working pressure of 6 kg / cm2.	1.008,00 €	24.192,00Br
3.4.2	Unite	PVC Unite GLUED JOINT 90, ND = 50mm PVC Te 90 with bonded joint, 50mm in diameter, placed in PVC pipe water supply, i / boards, not including since anchoring, fully installed.	1.044,00 €	25.056,00Br
3.4.3	Unite	ELBOW PVC GLUED JOINT 90 FF NP6, ND = 50mm. Female-female Elbow 90 ° PVC, with seal attached to a working pressure of 6 kg / cm2, 50mm diameter PVC pipe placed in water supply, including joints, not including anchors, fully installed.	€ 72.00	1.728,00Br
3.4.4	Unite	CAP REDUCCT. VESSEL TYPE PVC ND = 50/20 mm. Reducing PVC cap with seal affixed to glass type outputs elbow pieces of 50 / 20mm in diameter, placed in PVC elbow water situation started, including joints excluding the anchor.	344.10 €	8.258,40Br
		TOTAL Subchapter 3.4	2.468,10 €	59.234,40Br
Subcapí title 3.5:	PORTA BRANCHES DRIPPERS			
Order No.	Unite	Item description	€ / ud.	Br / ud.
3.5.1	meters	FLEXIBLE PIPING PE NP6, ND = 20 mm Pipe PE flexible nominal diameter 20mm, insert joint, for a working pressure of 6 kg / cm2.	26.040,00 €	624.960,00Br
3.5.2	Unite	GOTERO BUTTON WITH PRESSURE COMPENSATED 2l /F1-4bar. Compensated dripper button type, 2l /FOperating pressure between 1 and 4 bar flow.	48.825,00 €	1.171.800,00Br
3.5.3	Unite	TIMING CONNECTION 16mm X FOUR OUTLETS. Toothed female connection 3/4 "x four outputs for droppers tif button type 3/5" male.	20.925,00 €	502.200,00Br
3.5.4	Unite	FLEXIBLE PIPING PE NP6, ND = 16mm pipe flexible 16mm nominal diameter, insert joint, for a working pressure of 6 kg / cm2 PE.	50.220,00 €	1.205.280,00Br
3.5.5	Unite	GUIDE TO STAKE PE PIPES, ND = 16mm. Stake single stabilizer guide for PE pipes ND = 16mm installed and downcast	9.300,00 €	223.200,00Br
3.5.6	meters	STOPPERFglueing ND 20 mm. Female, PVC binding glue-6 atm, 20 mm nominal diameter to the	148.80 €	3.571,20Br

		drains of the branches, fully placed and tested plug		
		TOTAL Subchapter 3.5	155.458,80 €	3.731.011,20Br
		TOTAL CHAPTER 3	165.775,54 €	3.978.612,96Br
Chapter 4:	PUMPING SHED			
Order No.	Unite	Item description	€ / ud.	Br / ud.
4	Unite	PUMPING SHED 4x5m and height of 2 m. Casts to house the pump 4x5m and height of 2 m, hearth reinforced concrete HN-20 15cm thick reinforced concrete walls of the same characteristics as the solera of 10 cm thick and covered with fiber cement pimpled fabric cover 3 mm thick asphalt to waterproof the structure, fully assembled and installed.	5.000,00 €	120.000,00Br
		TOTAL CHAPTER 4	5.000,00 €	120.000,00Br
Chapter 5:	WATER PUMP			
Order No.	Unite	Item description	€ / ud.	Br / ud.
5	Unite	WATER PUMP CANTABRIAN Genergy 35000l / h, 36mca. Water Pump brand Genergy cantábrico model, 52x43x60 and 30kg, maximum flow 35000l / h, and the maximum air pressure 36mca, Genergy SG70 2CV engine, 4 - stroke air - cooled gasoline 7,7L.	550.00 €	13.200,00Br
		TOTAL CHAPTER 5	550.00 €	13.200,00Br

5. TOTAL BUDGET

TOTAL BUDGET			
Chapter 1:	TREE CUT and ROCK REMOVAL	4.995,00 €	119.880,00Br
Chapter 2:	EARTHWORKS	145.60 €	3.494,40Br
Chapter 3:	PIPELINES	165.775,54 €	3.978.612,96Br
Chapter 4:	PUMPHOUSE	5.000,00 €	120.000,00Br
Chapter 5:	WATER PUMP	550.00 €	13.200,00Br
EXPORT:	CONTEINER 40 FEET	1.600,00 €	38.400,00Br
	SHIPPING	1.600,00 €	38.400,00Br
	CUSTOMS ETHIOPIA	2.960,00 €	71.040,00Br

TOTAL MATERIAL EXECUTION	182.626,14 €	4.383.027,36Br

13% Overheads	23.741,40 €	569.793,56Br
0% industrial profit	- €	- Br
Suma EM + GG + BI	206.367,54 €	4.952.820,92Br
15% VAT	30.955,13 €	742.923,14Br

TOTAL BUDGET FOR HIRE	237.322,67 €	5.695.744,05 €

Ascend the general budget to the expressed amount of:
TWO HUNDRED SEVEN THOUSAND TRENTA THREE HUNDRED TWENTY EUROS AND SIXTY-SEVEN CENTS
O FIVE MILLION SIX HUNDRED NINETY FIVE HUNDRED THOUSAND FORTY FOUR AND FIVE CENTS BIRR

DOCUMENT 4: SUSTAINABLE DEVELOPMENT GOALS

Sebastián Sangro Lucas

1. INTRODUCTION

In this section, the different development indices will be analyzed in relation to Ethiopia, and in the cases in which the information is available, in relation to Gambella. In addition, we study the socio-economic and sustainability impact of the project on the local population and the local environment. To this end, a series of objectives and realistic and tangible results are established that help to follow the project completely, from its design, to its execution and abandonment.

2. ETHIOPIA, SUSTAINABLE DEVELOPMENT AND COOPERATION

2.1. Human and sustainable development goals

Ethiopia is one of the poorest and most vulnerable countries in the world, and this is reflected in all indicators. In addition, the severe droughts that periodically suffer are well known, which together with an overpopulation, creates famines that affect millions of people, only in that country. To analyze the situation in Ethiopia, use is made of the HDI indices of the United Nations. It compares each index with a developed country and not with a country of its environment since in this way the difference between a poor country and a developed country can be seen. The main indices and their implications are detailed below.

Between 2000 and 2014, the IDH of Ethiopia has gone from 0.3 to 0.45, which represents a notable improvement, although much remains to be done.

In terms of inequality, the HDI, adjusted for Inequality (HDI-D) is 0.312 while in Spain it is 0.775. This implies a loss of the total HDI by inequality of 29.4% (in Spain it is 11.5%).

The Gender Development Index (GDI) is quite high as it is 0.84 and in Spain it is 0.975. However, the gender inequality index (GDI) is 0.558 more than 5 times higher than in Spain (0.095).

In terms of poverty, the population in extreme multidimensional poverty is 67% and the working poor with incomes of $ 2 PPA per

day (% of total employment) 73.8%, which means that most of the country's workers live with Less than $ 2 a day.

The unemployment rate (% of the labor force) is 4.5%, well below the 26.5% of Spain. Young people who do not study or work (% young people between 15 and 24) are the 1.1%, while in Spain they represent 18.6%, which is reflected in the youth unemployment rate, 7.3% in Ethiopia and 55.5% in Spain, which is a plus point.
Environmental sustainability is another indicator of development. Emissions of carbon dioxide per capita are 0.1 tonnes and in Spain 5,8. The rural electrification rate (% of the rural population) is only 7.6%, in Spain 100%. The depletion of natural resources (% of GNI) is 14%, and in Spain 0%. The population living on degraded land (%) is very high, 72.3% while in Spain it is only 1.4%.

Ethiopia is also behind in education with developed countries like Spain. The expected 8.5 years of schooling are well below the 17.3 expected in Spain. Like the adult literacy rate (% of 15 years or more) that is 39%, while in Spain it is 97.9%. The population with at least some type of secondary education (% of 25 years of age and older) is 12.5% and in Spain of 69.8% and the student-teacher ratio is 53.7 students per teacher in
Ethiopia and 12.6 students per teacher in Spain. These figures do not reflect the budgetary effort made by Ethiopia, since public expenditure on education, 4.7% of GDP, is very similar to that of Spain, 5% of GDP.

Income is also a factor of comparison. Gross National Income (GNI) per capita was $ 1,427.7 in 2011, almost 23 times less than in Spain, $ 32,044.9 in the same year. The national food price index is 6.3 and in Spain 2 and the volatility index of the national food price level is similar in both countries, 9 and 8.4 respectively.

With regard to the Millennium Development Goals, the eradication of extreme poverty and hunger, one of the region's major hurdles, and environmental sustainability are particularly relevant to this

project, where it can be seen that Ethiopia has done a great deal of work. effort. The undernourished population (indicator 1.9) has gone from representing 74.8% of the population in 1990 to 30% in 2015, although it should be noted that the population has increased considerably during this period and that the gross number of undernourished people continues 35 million people since 1990. Other indicators are the proportion of the population with access to improved sources of drinking water supply (7.8), which has risen from 13% to 55%, with particular relevance in rural areas. 3% to 49%).

2.2. Cooperation partners development

Ethiopia is listed by the Development Assistance Committee, as a Least Developed Country (LDC), and is ranked 173 on the Human Development Index of a total of 187. However, the country makes great efforts to overcome poverty, as reflected in the strategic frameworks developed by the government, such as the Growth and Transformation Plan (GTP), approved in 2010, whose main objective is to lift the Ethiopian population from poverty in an equitable and sustained way, and meet or exceed the MDGs, now called ODS.
In Spain, Ethiopia was included in the Master Plan of Spanish Cooperation 2009-2012 as a Country of Broad Association (category A), and as such was maintained in the Fourth Master Plan (2013-2016).

The Country Partnership Framework (MAP) with Ethiopia has priority for health and rural development and food security, through organizations such as Caritas (a project in Oromia in 2014, 2.5M €), Aid in Action (a project in Oromia in 2014 with 2.5M €), Adra (a project in Somali region in 2014, € 2.5M), Friends of Silva (a project in Afar 2013), ATTSF (a project in Somali region in 2013), FPSC and Rescue (both in 2014, in Oromia and the Somali region respectively).
In recent years, the Horn of Africa has been hit by severe droughts, the last and most severe by the El Niño phenomenon, which have caused serious humanitarian crises; The AECID made two

extraordinary contributions, one in 2009 of € 75 million and another in 2011 of € 25 million.

The situation has improved since 2012 until the arrival of the Child's effects in 2015. In addition, Ethiopia is exposed to a series of dangers and disasters related to the country's diverse meteorological and socio-economic conditions such as floods, plagues, pests, epidemics, conflicts between Clans or tribes and others. It is also seriously affected by the influx of refugees fleeing conflicts in the region and neighboring countries. Ethiopia is one of the countries in the world that has received the most refugees in its territory.

In this regard, contributions have been made by Spanish cooperation to UNICEF, the OCHA Humanitarian Response Fund and the ICRC in 2012 for a total of € 1.7 and the International Federation of the Red Cross in 2014 with € 25,000
On the other hand, in 2014, the first Public Private Partnership on Humanitarian Action of the AECID (APPAH) was launched to respond to the energy needs of refugees from Eritrea in the Shire area of the north of the country. This Alliance was made through the granting of a subsidy of € 160,000 to the Center for Innovation in Technology for Human Development of the Universidad Politécnica de Madrid (ITD-UPM), with the participation of UNHCR and private companies such as Acciona, Iberdrola And Phillips Ibérica.

2.3. Conclusions

It is understood that Ethiopia is a vastly different country in terms of cultures, ethnicities, languages and climates, with a history that is lost in time, and convulses as the most, which has led the country to a socioeconomic situation that Has so far prevented them from getting out of poverty. Many efforts have been made and for a long time, and although the situation has improved, the Ethiopians are facing new challenges such as the phenomenon of the Child, and the increasingly severe droughts left behind. In addition, the efforts are diluted in a population that grows frantically, being already the

second most populous country of Africa.

That is why it is important to take into account that local efforts are very difficult to assess, and it is necessary to assume that the project is part of a larger, long-term synergistic entity and in which the main actor is the beneficiary. However, it is important to properly define the objectives and results, as well as the methods of verification and the data expected to be able to realistically monitor the project at all stages, so that it can be improved at any time.
The various Ethiopian governments have made a lot of efforts to improve the country, especially in the rural area, since 85% of the population has work related to agriculture or livestock.

In Gambella, the situation created by the sale of large parcels of land to foreign companies, along with the massive influx of refugees, has led to a humanitarian crisis that has wreaked havoc on local populations and tribes since 2014. It is necessary to take this aspect into account in the implementation of the project, since this crisis has resulted in an ethnic conflict that obliges the beneficiaries to be of different ethnicities in the most equitable way possible, and always taking into account the opinion of The local tutors.

It is important to implement irrigation systems and improve water use, to supply the growing population. Water is a scarce commodity, and in the Gambella region it can be envisaged that when the crops of private enterprises are at their peak, it will be even more difficult to supply the local population with less conventional methods.

In short, the plan in which the project is framed, developed and carried out by the technical school Don Bosco, is essential to alleviate the extreme situation in which the area is located. This plan is to provide agrarian education in the form of official VET degrees to women from different communities in the region. This will take into account cultural, agro-ecological, geopolitical, market, practical, and other aspects with a view to sustainable and resilient use that gives rise to an exemplary plot for the rest of the

population.

3. APPROACH TO THE PROPOSED PROJECT

3.1. Logical Framework Approach

In the first place, and thanks to a first analysis of the initial situation, it is possible to define the problem that is the object of the project. In this case, given the data studied in the "Background and Condition" annex, the main problem is the lack and difficult access to agricultural technical knowledge, and the related problems are extreme poverty and malnutrition. The objective of the official agricultural PF course is to alleviate this lack of knowledge. It will be able to enroll up to 90 students a year and it is expected that, once the knowledge is established, the productions in their respective plots increase, thus reducing malnutrition related to low production and low food diversity. The surplus, which will be achieved with time and practice, will be marketed in local markets, thus increasing family incomes and improving the local economy.

On the other hand, the majority of students come from remote areas, without access to public transport, and also come from extremely poor families so they can not travel every day to school, let alone "eat out". In order to alleviate this problem, and to encourage the arrival of female students from rural and isolated environments, a building of shared rooms has been built close to the classroom, where students will be accommodated during the week (and weekend if they wish) . In addition, they are provided three meals a day with which they also have covered the food needs. It will be the practice farm that provides the majority of food.

In this way, the specific objectives of the intervention are defined.

- Create a vegetable garden for the production of vegetables: In it will be taught the practices of the course of agriculture

and food will be obtained for the students.

- Diversify the diet of the population and improve the nutritional status and health of the population, especially the younger and women: through the introduction of new vegetables, to improve health status.

- Promote the participation of the inhabitants of the area: through the recruitment of settled inhabitants near the farm, and their inclusion in agricultural courses.

- Provide technical assistance and training to those involved in the project: developing an educational program (FP) that allows the beneficiaries to learn sustainable farming techniques, to know new crops, in addition to their process of conservation and cooking.

- Favor the economic development of the school through the commercialization of production: establish a distribution channel for short and direct food products that ensures the exit of most of the surplus.

- Foster the development of the female population by empowering women with the necessary technical and economic skills to increase family incomes through agriculture.

The tree of causes and effects shown below, schematically lists the problems and their causes.

Tabla 1: Problem tree. (Own elaboration)

PROBLEM TREE		
DEFICIENT AGRICULTURAL TECHNIQUES	EXTREME POVERTY	MALNUTRITION

Low agricultural knowledge, low diversity, inefficient and unsustainable. Low production, inability to take risks to improve.	Very little or no income. Difficulty improving the economy due to insufficient resources.	Decrease of the physical-intellectual development of the younger population. Poor academic performance and vulnerability to diseases

Tabla 2: Goal tree. (Own elaboration)

GOAL TREE	
General objective:	Improvement of the quality of life of the local population through the socio-economic and cultural development derived from the increase and diversification of the agricultural production that is obtained thanks to the course of agriculture and the recruitment of personnel.
Specific goal:	Create a vegetable garden for the production of vegetables
	Diversify the diet of the population and improve the nutritional status and health of the population, especially the youngest and women
	To promote the participation of the inhabitants of the zone:
	Provide technical assistance and training to those involved in the project
	To favor the economic development of the school through the commercialization of the production:
	Foster the development of the female population:

Tabla 3: Causes and effects tree. (Own elaboration)

CAUSE TREE	Agricultural underdevelopment	Low educational level	Very low family income	Gender Inequality	Social underdevelopment	Bad environment conditions
	Little variety of crops	High percentage of illiterate population	Lack of opportunities	Patriarchal society	Ancestral and conservative customs	Inequality in land distribution
	Rudimentary cultivation methods	Poor follow-up of secondary or technical studies	Subsistence economy	Most Vulnerable Women	Rigidity of social structure	Concentration of extensive land by multinationals
	Few or no agrarian knowledge	Women Most Vulnerable	Very low wages	Less access to education and employment	Poor coexistence between tribes	Rainfall only for 6 months a year
	Difficulty in financing		Temporary employment		Government and arbitration institutions	Poor resource management
	Uncertainty about the possession of land from one year to another					Environmental mismanagement
						War in neighboring South Sudan: arrival of refugees
EFFECT TREE	Poor diet and low incomes.	Little perspective on decision making.	Needs covered day by day. Situation in which they do not have the means to expect medium- to long-term income	Little or no female decision-making ability.	Lack of youth motivation, initiative and competitiveness.	Few opportunities for development.

3.2. Analysis of the project

Availability and capacity of the land: the available area for the production of the orchard is 30 ha, from which inputs are also obtained. Other terrain of the environment has a production of medium to low so it is expected that the capacity of the terrain is not the best. It is estimated that the average production will be around 7 tons per hectare.

Facility for implementation, management and maintenance: the orchard manager, the practice teacher, and some teachers are members of the local tribes and knowledgeable about the techniques used by the populations. In addition, the Salesians of Gambella are Ethiopians so they know the local culture and customs. This corresponds with a perspective of cooperation that seeks to integrate the local population in the management of projects, to ensure their long-term sustainability.

Viability and sustainability: the integration of teachers and students of the school members of the local tribes, making them from beneficiaries to actors, ensures the operation of the project without external intervention.

Organizational Comparative Advantage: The location of the estate, near the city, and the school, in the city, offer the advantage of being able to cultivate an important extension of land at the same time that the classes are taught in covered in the classrooms of the school. In addition, the school offers the advantage of existing facilities such as sports grounds, rooms, cafeteria and so on.

Priorities for beneficiaries: teachers, students and workers are the three groups of direct beneficiaries. For the selection of students, priority is given to women from remote rural areas, from local tribes. The hiring of workers for certain agricultural work will be done giving priority to the inhabitants of the village where the farm is located.

Suitability of stakeholders and / or beneficiaries: The enthusiasm

shown by the project by the different actors involved, both institutional and personal, testifies to the willingness of Gambella society to host the project. It should be noted that it is the women who take care of agriculture and the men of the cattle ranch, reason why this project adapts to the local customs and traditions. On the other hand, the teachers who will teach the classes are approved by the Ethiopian government and are adequately trained for the task entrusted.

Environmental value: local people depend to a great extent on the state of conservation of their forests, which is where they obtain most of their resources: wood, coal, medicinal plants, honey and other bee products, food, hunting and fishing. It is therefore of vital importance that when introducing new agricultural projects the forests or part of them are maintained to ensure a family income to these communities in case the project does not go forward. It also brings benefits to the production of the farm since a healthy soil with a high biological diversity favors the absorption of nutrients by the plants. To do this, avoid all aggressive agricultural techniques, such as broad spectrum pesticides, continuous landfills, lose the entire tree population at one blow and others. All these aspects will be encouraged through the farm, and taught in the courses of agriculture.

Formative value: Through the training courses for women, a part of the key society is empowered to transform the lives of people. Thanks to the knowledge acquired and the technical support of the Don Bosco school, the students will be able to improve their productions and increase family income.

Budget and deadlines: The assignment of the land by the local government, for the agricultural course of the school, is a unique opportunity as they are highly quoted land because of its proximity to the river. This is an economic advantage when it comes to designing the project. On the other hand, the calendar of agricultural management adapts to the Ethiopian school calendar, from September to June, to improve the educational experience.

3.3. Planning Matrix

The planning matrix or logical framework schematically relates the objectives to their results, and objectively verifiable indicators. In this case, given the difficulty of accessing diverse markets, the indicators should be as simple as possible so that they can be properly verified.

Tabla 4: Planning Matrix. (Own elaboration)

PLANNING MATRIX				
	DESCRIPTIVE SUMMARY	VERIFIABLE INDICATORS	SOURCES OF VERIFICATION	HYPOTHESIS
GENERAL OBJECTIVE	Improvement of the quality of life of the local population through the socio-economic and cultural development derived from the increase and diversification of the agricultural production that is obtained thanks to the course of agriculture and the recruitment of personnel.	Agrarian production, Family income, Health status, Evolution of weight and height, Decreased conflict,	Production follow-up, family income, health questionnaires, weighted-state development curves	There are no relevant political and / or social changes
SPECIFIC OBJECTIVES	Create a vegetable garden for the production of vegetables	First productions	"In situ"	
	Diversify the diet of the population and improve the nutritional status and health of the population, especially the youngest and women	Vegetable production-Weight and height, health status of the participants	"In situ"	
	To promote the participation of the inhabitants of the zone:	Number of participants in courses and contract workers	Payroll, job attendance control and activities	
	Provide technical assistance and training to those involved in the project	Training courses	Control of attendance to courses	
	Favor the economic development of the school through the marketing of surplus:	Amount Sold	Track Sales	
	Foster the development of the female population:	Women participation	Number of participants in the course	
RESULTS	Promotion of a new activity in the technical school Don Bosco de Gambella through the new course of professional training of agriculture.	Active participation of the students in the orchard through the practices of the agriculture course, led by a trained teacher	Assist Control	Participants show interest and are involved in all stages of the project
	Creation of an orchard that constitutes a complementary food source for the students and the local population.	The objective is considered fulfilled if 80% of the expected production is reached.	Production control	Adequate adaptation of crops to the environment
	Implantation of crops consumed, but not cultivated by the local population, so that in the near future they will self-supply most of the food they would otherwise buy in other regions of the country. Marketing surplus and improving the family economy.	Families spend less on food and can spend money on other activities. Increase in income	Family expenses and income registration	Enthusiasm for growing products that are expensive. Acceptance of new foods.
	Training of the people responsible and involvement of the population in the	The local population together with the	Evaluation of those responsible	The orchard stimulates the interest of the local

	development and maintenance of the orchard once the project completion period has been completed.	foreman and the trainee teacher must be able to carry out all agricultural work for adequate production		community involved from the outset
	Training of women in rural areas of the Gambella tribes in sustainable, effective, productive and diversified agricultural practices that contribute to the improvement of their families.	Increased agricultural knowledge	Assessment of female students	Students and teachers do everything to improve working conditions and transmit the greatest amount of knowledge.
ACTIVITIES	Study of local agriculture and the environment: resources, crops, media, techniques, dates, production, yields, access to inputs, main pests. Agroclimatic and edaphological study of the farm object of the project.			
	Reflection to identify strengths and weaknesses.			
	Preparation of the project document			
	Development of the necessary infrastructures: Building of classrooms, building of dormitories, building of dining room, orchard, system of irrigation, house of irrigation and roads.			
	Development of the productive process: preparation of the seed bed, planting, work and cultivation operations, and harvesting.			
	Beginning of Agriculture courses			
	Homologation of titles			

3.4. Logic and analysis of the intervention

The sustainability of the project is guaranteed since all the inputs are obtained from the farm or the surrounding land, and with them the nitrogen needs of the crops are covered.

Long-term development relies on project managers and participants and their technical skills, their work in the school and the garden, and their ability to teach and learn.

The training of the participating women will contribute to the development of their families and communities as they will be able to share the knowledge acquired. The teachers are in charge of this training, in the classroom of the school and the orchard of practices, and the didactic material provided by the Ethiopian government for

approved VET courses.
This fundamental to achieving the objectives of the project, training is analyzed in terms of so- called *feasibility factors:*

- *Technology:* The size of the farm, obtaining inputs and minimum use of tractors for the work is fully consistent with the conditions in the middle, as new technologies such as agricultural machinery difficult to obtain in Gambella are introduced. In addition, thanks to the surplus will earn income to deal with the materials, repairs, and seeds needed for the development of the garden.

- *Sociocultural transformation:* with the introduction of crops consumed but not cultivated the vision that the local population on these crops and the ability to grow it themselves change, and gives a good example for other communities to imitate them, completely changing the socio-economic model of small villages.

- *Environmental protection:* because of the socio-economic conditions, forestry and agricultural practices of the local population are extremely harmful for the environment and for the long - term livelihood of these communities. The introduction of sustainable practices ensures adequate production and maintains the fragile biological balance of the farm's soil and the surrounding forests.

- *Financial Factor:* participants' agricultures courses will be covered with everything they need to start a harvest. With the benefits or savings provided by such harvest, and the technical assistance of the school, the students will face the next harvest.

Efficacy: It has been able to be effective in the use of time, given the circumstances. It has been possible to analyze and identify the weaknesses, threats, opportunities and advantages during the stay in the region. In addition, it was possible to contrast all the agroclimatic and edaphological data for the realization of the project document and to establish permanent relations between the different agrarian institutions of the region as the university of agriculture, the department of agriculture or the agrarian research

center of Gambella. On the other hand, it was possible to verify the involvement and the enthusiasm of the local population in relation to the project, and especially their needs and wants.

Efficiency: the relationship between the resources used and the results achieved is satisfactory, since the justification for the stay in Gambella is the project document, with the agroclimatic and soil study and the list of vegetables best suited to the farm. Hydraulic calculations are also provided for the irrigation system, the budget, the financial assessment, as well as the irrigation schedule and the necessary inputs.
On the other hand, it is hoped that, thanks to the VET courses, each participant can support a family, and be an example for an entire community, which are usually around 50 people. Therefore, for each participant it is expected that another 50 people in their immediate environment will benefit indirectly.

DOCUMENT 5: ENVIRONMENTAL IMPACT STUDY

Sebastián Sangro Lucas

1. PROJECT DESCRIPTION AND ACTIONS

1.1. Purpose and justification of the project

The aim of the project is to transform and set up a garden of 15ha for the Don Bosco vocational school in Gambella. The estate undergoing processing is 30 hectares and is situated 12 km south of the capital of the Gambella region, also called Gambella.

The project is justified by the opportunity given by the possession of that land to the promoter, given by the local government expressly for the agricultural course and for the school. Thus, the plot of an initial state of productive abandonment will be transformed into a quality orchard, with sufficient production to self-supply the school.

1.2. Location

The estate undergoing processing is 30 hectares and is situated 12 km south of Gambella, in the region of the same name. This city lies 700 km west of Addis Ababa, capital of Ethiopia, and the Gambella region borders South Sudan. The farm is beautiful to the north with small unmarked plots belonging to members of the Anuak tribe settled in the area. To the east is an unpaved road, which leads from the paved road to the river and runs along the edge of the estate. To the south, the estate delimits with the asphalted road that takes of Gambella to Addis Ababa. To the west the limit is given by a tributary of the river Baro that is dry for six months to the year.

The exact location is: Grades sexagesimales 8º 10 '20.84' 'North-34º 39' 26.51 '' West and in decimal degrees 8.172455, 34.657364

1.3. Establishment, exploitation and closing phases

During the establishment phase, the following actions will be carried out:

1- Actions related to the preparation of the land: clearing of vegetation, clearing of trees, landfill work, dewatering, minimum leveling of the ground, and formation of horsemen.

2- Actions related to the installation of the irrigation network: opening of ditches for pipes.

Once the establishment phase has been completed, the exploitation phase will begin. In this new stage, the following actions will be carried out:

1- Actions related to the sowing process: Adjustment of the riders, placement of the driving system where appropriate (tomatoes, beans and other climbing plants), workers' income to plant.

2- Actions related to care and cultivation techniques: Pruning, irrigation and soil maintenance through the manual incorporation of organic amendments.

3- Actions related to the harvest: harvest of the products and transport to the Don Bosco school.

After the closure and abandonment of the operation, recovery will be carried out. Schematically, the actions carried out by the development of the project are clearly exposed in the action tree.

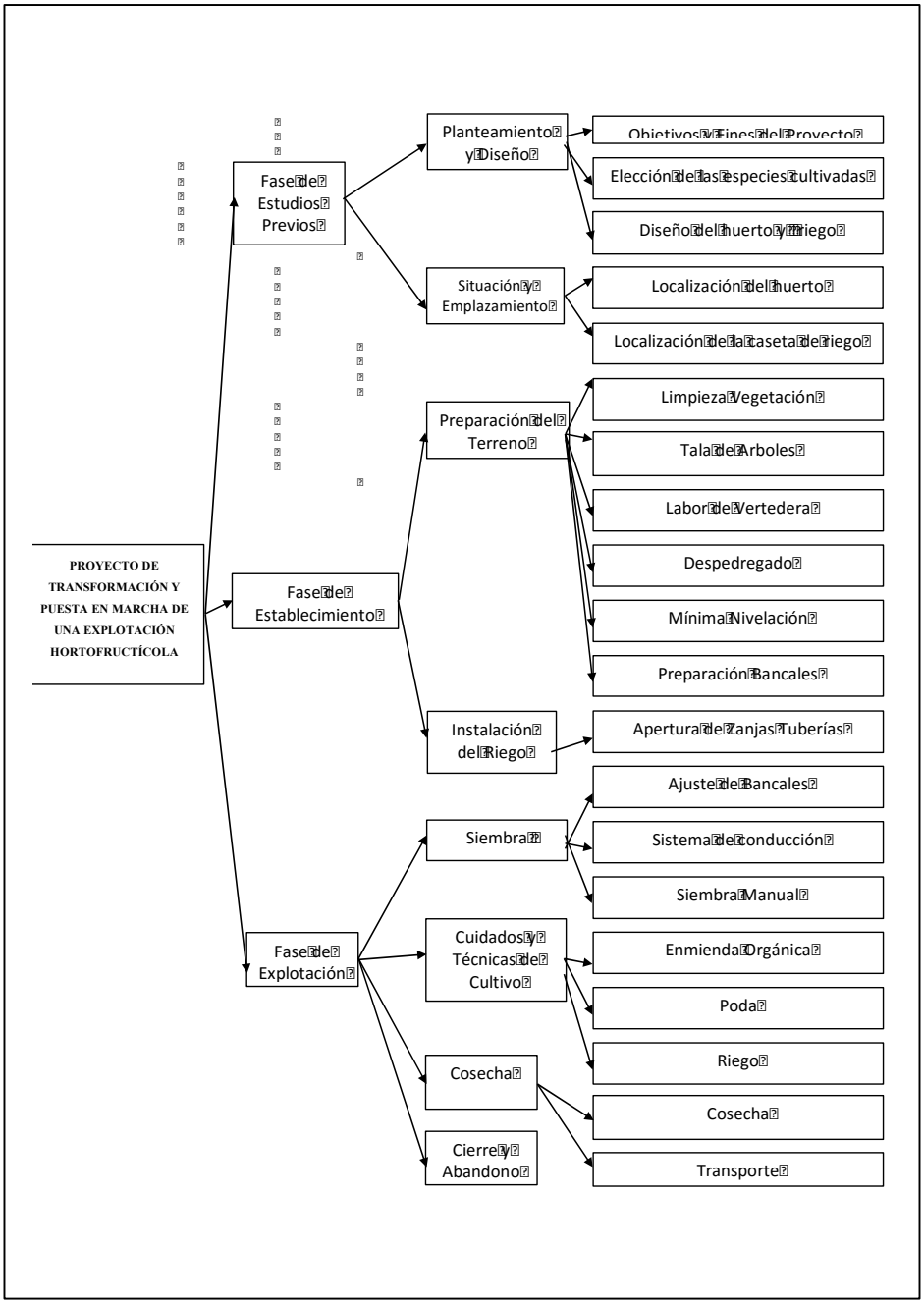

Figura 1: Action tree of the project. (Own elaboration)

1.4. Examination of alternatives

1.4.1. Situation without project

Without the realization of the project the terrain will remain in disuse and consequently the right of exploitation will be withdrawn by the local government. If that happens the vocational school will not be able to teach the course of agriculture and all the efforts and investments made to date to create it will have been in vain.
On the other hand, the land can continue as it is, ie virgin, or be ceded to another organization that carries out a social work in the field of agriculture, or in the worst case, can be rented to a multinational.

1.4.2. Alternatives (Project solution)

After analyzing all the strategic alternatives in the project, the set of decisions taken regarding the different possibilities of execution of the project are the following:

- **Choice of species** has established a ranking of species that are best suited not only to agro - climatic factors, but also socio - economic factors.
-Election Variety: the variety best suited be chosen among those available.
-Election The type of irrigation: The chosen irrigation is drip irrigation compensated drippers four outputs, with a frame between droppers 40x40cm
-Election Rotation: You have established a set of rules for the election of rotations and different symbiosis between species.
- **Getting inputs:** They booked 15ha of land for the production of organic materials and other inputs such as honey, aromatic plants and wood. In addition, trees in that area will be replaced by fruit trees such as mangoes, bananas, papayas or dates among many others.
-Election Site: We have chosen the area closest to the river for the establishment of the garden for saving energy in water transportation. The 15ha mentioned above will be spread over the rest of the land and around the orchard.
-Anti Weeds: Given the socio economic circumstances and the type of irrigation choice, the best way to fight weeds is manual control with the help of tools.

1.4.3. Factor tree

All the data on the environmental inventory of the area previously exposed in the study of antecedents and conditioners, can be related schematically in the factor tree, being the following:

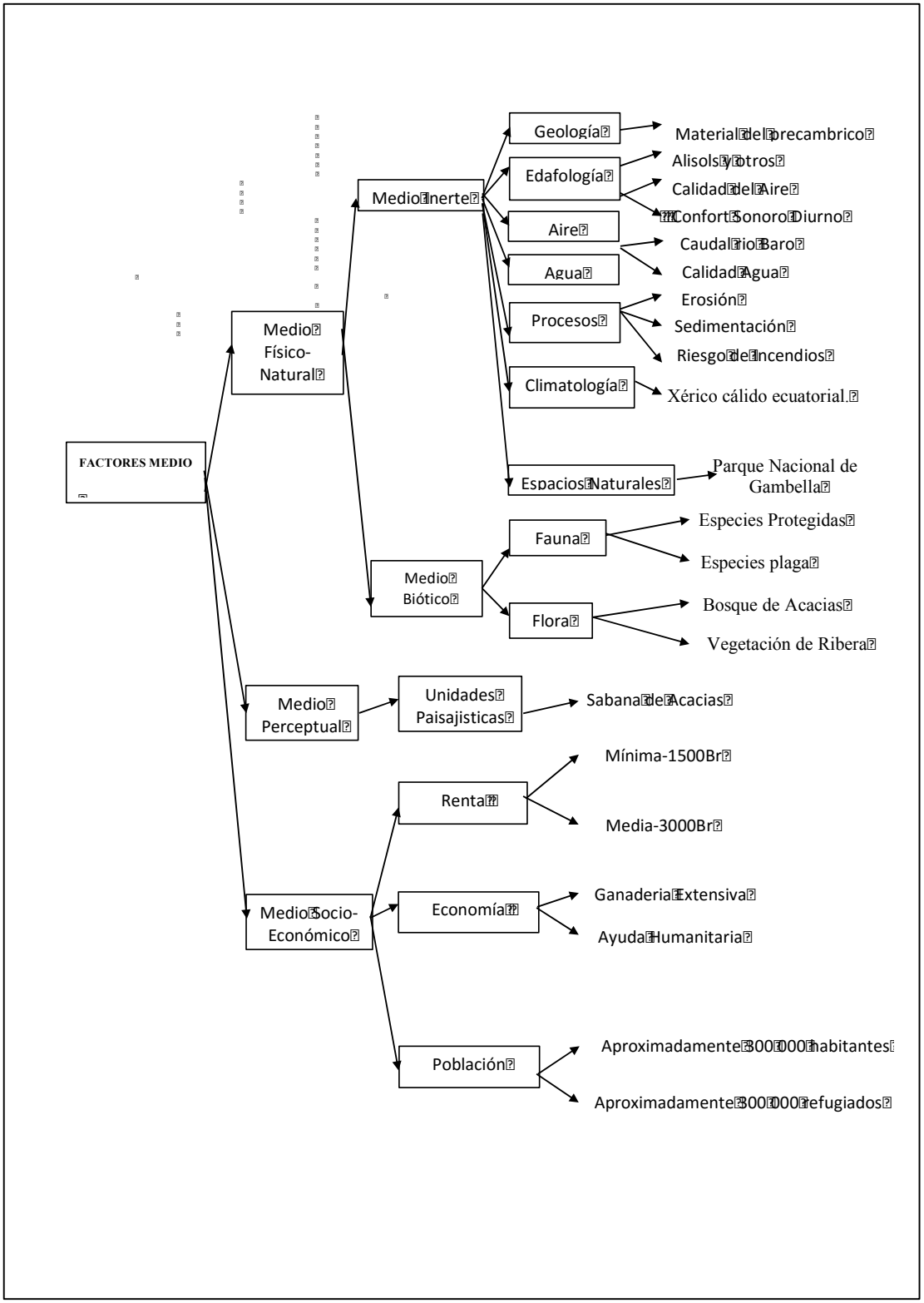

Figura 2: Means factor tree. (Own elaboration)

1.5. Significant impacts matrix

By relating the actions to the factors they affect, we obtain the matrix of significant impacts:

			Factores Ambientales										
			Medio Físico-Natural							Medio Perceptual	Medio Socio-Económico		
			Calidad del aire	Clima	Geología y Edafología	Procesos	Agua	Ecosistemas	Fauna	Paisaje	Usos del suelo	Población	Economía
Acciones del Proyecto	Fase de Diseño	Localización										+++	++
	Fase de construcción	Delimitación y acondicionamiento de los espacios de la obra						-	-	-	-		
		Despeje y desbroce	- -			- -		- - -	-	- - -	- - -		++
		Tala de árboles	-		-	-	-	-		-	-		++
		Mov. De tierras y realizacion del firme de tránsito	- -		- -	- - -		- -	-	- -	- - -	-	++
		Tránsito de maquinaria	- - -		-	- -		- -	- -	-		-	
		Cimentación de la caseta e instalacion de los sistemas de riego			-	- - -		-	-		- -		++
		Construccion de lla caseta de riego				- - -		-	-	- - -	- - -		+++
		Eliminacion de los materiales sobrantes e instalaciones provisionales				+	+	+		+	+		+++
	Fase de explotación	Reacondicionamiento en cada nueva temporada							- - -	- - -		+++	
		Cosecha del producto	-						-			+++	+++
		Mantenimiento de las instalaciones y de la plantacion			-	- - -	- - -	- -	- -			+++	++

Figura 3: Significant impacts Matrix. (Own elaboration)

2. IMPACTS IDENTIFICATION, EVALUATION AND FALLOWING

In this section, for each factor, the actions that affect it are analyzed and its impact is evaluated with the use of several indicators. In addition, the necessary corrective and follow-up measures are developed to minimize the impacts associated with this factor of study.
The factors to be developed will be the following:

- Soil and geology.
- Fauna.
- Vegetation.
- Landscape.
- Socioeconomic environment.
- Hydrology.

2.1. Soil and Geology

For this factor, the selected impact is caused by materials displaced by wind erosion.
Erosion is defined as the displacement of surface soil materials by the effect of atmospheric agents. The map of erosive states in the upper Nile basin, drawn from the universal soil loss equation, shows the approximate amount of losses in tonnes per hectare per year:

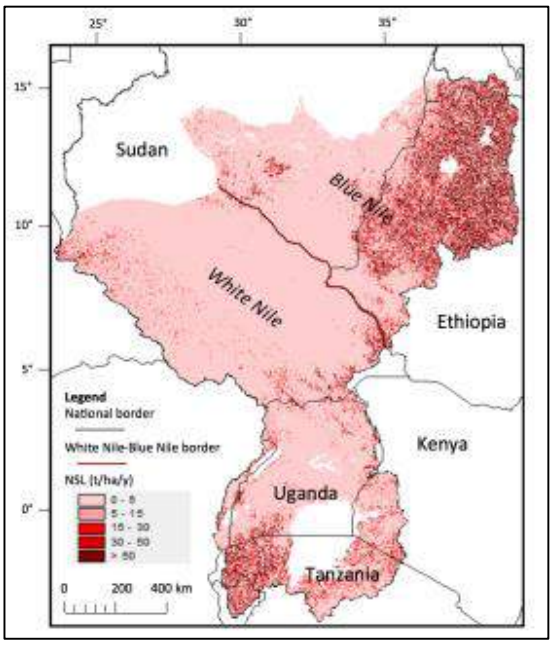

Figura 4: Wind erosion of the soil in the White and the Blue Nile watershed. (Source: Springer)

The Gambella region is represented in figure 4, and it can be observed that it coincides with the pink zone, with annual soil losses of 0 to 15 tons per hectare.
Tolerable levels of erosion are established for agricultural soils, above which soil conservation measures such as renovation with organic matter and other farming

practices should be taken.

Tabla 1: Permissible losses depending on the type of soil. (Source: ISRIC)

Type of soil	Acceptable losses
Shallow sandy soil	4-7 t / ha · year
Sandy and clayey soils	6-8 t / ha · year
Clay soils, deep and fertile	8-12.5 t / ha · year

Our soil has a clay-loamy texture and is quite fertile, so it would fall into the category of soils with the highest tolerable annual erosion. Despite this, and that organic waste from other parts of the farm will be incorporated into the soil, tillage and the consequent elimination of pre-existing vegetation cover make it much more susceptible to erosion losses due to the impact of water droplets and the wind.

However, this increase in annual soil loss due to the establishment of the orchard will be partially counteracted by the addition of organic amendments, which will be common and very necessary due to the difficult access to other resources for the subscriber, especially nitrogenous.

2.1.1. Situation without Project

Before the establishment of the orchard, the soil is occupied by a dense vegetation cover that reduces the magnitude of the erosion.

Description	Surface (ha)	Losses (t / ha.year)
Vegetable cover (Reduces erosion)	fifteen	5

2.1.2. Situation with Project

The actions of the project that are considered are the works of preparation of the land, major causes of the elimination of the vegetal cover and that therefore favor the erosion:

Description	Surface area (ha)	Losses (t / ha.year)
Vegetable cover (Reduces erosion)	0	5
Land preparation work (favor erosion)	15	18

2.1.3. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	Cumulative 3
Synergy (S)	Synergistic 3
Moment (M)	Medium Term 2
Persistence (P)	Permanent 3
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	Newspaper 3
Continuity (C)	Not Continuous 1

Where 1 means that it is better and 3 is worse.

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$I = 3 + 2 \times 3 + 2 + 2 \times 3 + 2 \times 1 + 2 \times 1 + 1 + 2 \times 3 + 3 = 28$$

Standard Incidence:

$$I_S = \frac{I - I_{mín}}{I_{máx} - I_{mín}} = \frac{28 - 14}{42 - 14} = 0{,}5$$

2.1.4. Magnitude

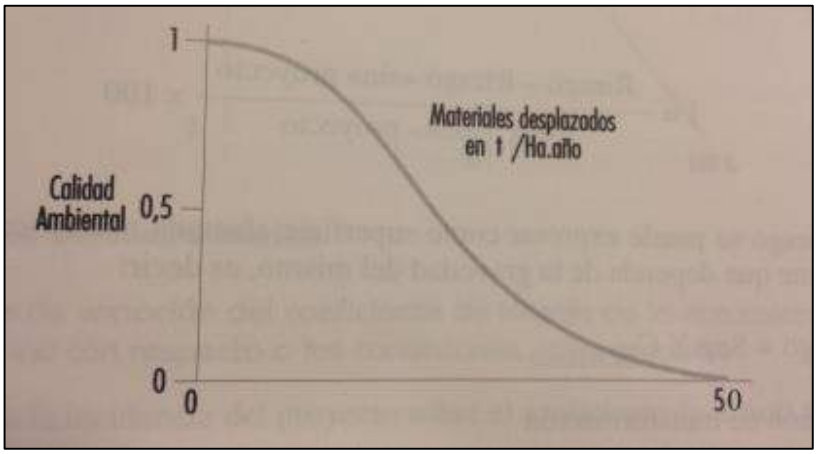

Imagen 1: Transformation function for displaced materials (soil erosion).

I = Amount of material moved in kg / m ^{2}

$$I_{without} = \frac{[\Sigma(Sup_i \times V_i)]}{Sup_{total}} = \frac{15\times4}{15} = 5\ t/ha \cdot year \text{->}\ 0.95$$

$$I_{with} = \frac{[\Sigma(Sup_i \times V_i)]}{Sup_{total}} = \frac{[(15\times18)]}{15} = 18\ t\ /ha \cdot year \text{->}\ 0.75$$

V_i being the material moved in the unit I and Sup_i the surface of the unit i.

$$I_{with} - I_{without} = 0{,}95 - 0{,}75 = 0{,}2$$

2.1.5. Evaluation

$$V = I_S \times Magnitud = 0{,}5 \times 0'2 = 0{,}1$$

Given the reduced value of the impact, we conclude that it is an impact compatible with the agricultural activity that is intended to be implemented.

2.1.6. Applied Measures

The establishment of a permanent vegetative cover in the streets and stones of different sizes at the edges of the subplots, starting from the first year of exploitation, shall be established as a corrective measure. This measure, besides reducing the movement of material by the action of wind, will reduce the magnitude of the erosion due to the action of the water and the compaction caused by the entrance of personnel in the field.

Tabla 2: Measures applied on geological and soil impact. (Own elaboration)

Protective measures	
Impact to which it is directed	Wind erosion of the soil
Definition of the measure	Permanent plant cover
objective	Avoid the movement of soil material due to the action of the wind.
Effectiveness	high
Description of the measure	Establishment and management of vegetation cover per nent in the streets of the operation and placement of stones between the subplots.
Entity responsible for its management	Owner or responsible farm management.
Moment in which it is included	From First Year

2.2. Fauna

The following section will measure the impact on the number of protected species in relation to pre-action conditions.

2.2.1. Wildlife inventory

Because of the constant mobility of the species in the area, its seasonality, the difficulty of locating them and the limits of the project are not too significant, the description of the fauna is complicated.
In the region of Gambella are located several forest masses of Acacias and to a lesser extent exemplars of other savanna species that represent the typical formations of the terrestrial ecosystem of the study area. The wetlands and ponds, occupied by small aquatic plants, represent the aquatic ecosystem that welcomes the local avifauna as a territory of shelter, food and breeding.

Being relatively small and close to the city, it is not expected to find large mammals. On the other hand, according to the IUCN red list, in the area of Ethiopia and South Sudan only 12 species of birds and 3 species of mammals are at risk. There are no cataloged species of arthropods or arachnids and the river fish stocks (including mollusks and crustaceans) are not affected by the project at any stage. Therefore, for the study of environmental impact will only refer to the poultry fauna as it is not only the most representative of our land, but also the most vulnerable.
The number of bird species that can be found in Gambella throughout the year is immense. Many are migratory birds that pass in this region a period of the year, but others can only be seen here. The latter include especially the Widow of Paradise (Widow paradisaea), the red - throated bee - eater *(Merops bulocki),* emerald bee - eater *(Merops orientalis),* and the Shoebill *(shoebill).*

As mentioned before, there are 12 birds listed on the IUCN Red List. Depending on their conservation status, they receive a category within the list: LC-Least Concern, DD-Data Deficient, NT-Near Threatened, cd-conservation dependent VU-Vulnerable, EN-Endangered, CR-Critically Endangered.

2.2.2. Cataloged potential wildlife

Each year the IUCN produces a list, called the red list, where it catalogs the different living species according to their state of conservation in nature. In its database, the search for species can be fine-tuned depending on the geographical area, among many others. For the Gambella area, data have been obtained on Ethiopia and Southern Sudan since the project is located in a border area between both countries. It highlights the fact that most of the endangered species in this area are birds. Among other things, this is due to the fragile balance that these species maintain with their environment since they can travel thousands of kilometers to reach their respective destinations.

In the following table you can see the list of species included in the red list and their respective categories according to their conservation status:

Tabla 3: Species of protected birds in the Gambella area. (Source: www.iucnredlist.org)

Birds					
Common name	**Species**	**Gender**	**Family**	**Order**	**IUCN**
Brown dump	Aythya nyroca	Aythya	Anatidae	Anseriformes	NT
Slippery cobweb	Calidris ferruginea	Calidris	Scolopacidae	Charadriiformes	NT
Eurasian Oystercatcher	Haematopus ostralegus	Haematopus	Haematopodidae	Charadriiformes	NT
Needle colipinta	Limosa lapponica	Limosa	Scolopacidae	Charadriiformes	NT
Colinegra Needle	Limosa limosa	Limosa	Scolopacidae	Charadriiformes	NT
Royal Curlew	Numenius arquata	Numenius	Scolopacidae	Charadriiformes	NT
Dwarf flamingo	Phoeniconaias minor	Phoeniconaias	Phoenicopteridae	Phoenicopteriformes	NT
African Racer	Rynchops flavirostris	Rynchopidae	Rynchopidae	Charadriiformes	NT
Common walnut	Aythya ferina	Aythya	Anatidae	Anseriformes	VU
Picozapato	Balaeniceps rex	Balaeniceps	Pelecaniformes	Balaenicipitidae	VU
Malagasy canastera	Glareola ocularis	Glareola	Glareolidae	Charadriiformes	VU
Sacral hawk	Falco cherrug	Falco	Falconidae	Falconiformes	IN

2.2.3. Situation without project

- The land is completely virgin, so the species inhabit or circulate through it.
- There are wetlands and ponds in the study area that shelter bird species.
- There is no presence of machinery that fragments habitat or that generates migrations because of the noise and the decrease in the quality of the air

2.2.4. Situation with Project

- When building, the mobilization and storage of certain materials, as well as the machinery, may imply a blockage of the passage for certain protected species.
- The work of the soil eliminates the presence of surface water.
- The presence of machinery fragments habitat, decreases air quality and sound quality.

2.2.5. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	Simple 1
Synergy (S)	No Synergistic 1
Moment (M)	Medium Term 2
Persistence (P)	Permanent 3
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	In the Newspaper 1
Continuity (C)	Continuous 1

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$I = 3 + 2 \times 1 + 2 + 2 \times 3 + 2 \times 1 + 2 \times 1 + 1 + 2 \times 1 + 1 = 21$$

Incidence Standard:

$$Is = \frac{I - Imín}{Imáx - Imín} = \frac{21 - 14}{42 - 14} = 0{,}25(\text{Magnitud})$$

2.2.6. Magnitude

Valuation indicators will be calculated for the situation without project and project. Subsequently it will be interpolated in the transformation function to measure the variation of the environmental quality.

$$I = \left(1 - \frac{\text{Num. de especies protegidas}}{\text{Num. de especies protegidas en la situación "sin Proyecto"}}\right) \times 100$$

$$Isin = (1 - (12/12)) \times 100 = 0\%$$

$$\text{Environmental quality} = 1$$

It is hoped that in the worst case all protected birds will be displaced from 15ha where the orchard will be installed. Therefore, the incidence with project will be.

$$Icon = (1 - (0/12)) \times 100 = 100\%$$

$$\text{Environmental quality} = 0$$

$$\text{Magnitud} = \text{Environmental quality without project} - \text{Environmental quality with project}$$
$$\text{Mg} = 1 - 0 = 1$$

2.2.7. Evaluation

$$\text{Is} * \text{Magnitud} = 0{,}25 \times 1 = 0{,}25$$

2.2.8. Applied Measures

Due to the high incidence value of the establishment and start-up of the orchard in protected species, in relation to the pre-action conditions, the 15 ha reserve on the farm is established as a corrective measure. Will take special care of the nests and will favor the nesting of birds by creating artificial nests depending on the species. In addition, the local population will be instructed on the importance of maintaining a diverse bird population and will encourage its conservation.
In this way and with the fruit trees that are intended to be planted, it is expected that, in the eyes of the birds, the attractiveness of the wooded part of the farm will increase, and the population in that area will not be affected, even increasing.

Tabla 4: Measures applied on fauna impact. (Own elaboration)

Protective measures	
Impact to which it is directed	Birds
Definition of the measure	Creation of artificial nests
objective	Increase bird's eye appeal
Effectiveness	Half
Description of the measure	Special attention must be paid to natural nests, protecting them at all costs, as well as to the habitat of said nest. In addition, artificial nests will be created to increase the attractiveness of the farm in the eyes of the birds.
Entity responsible for its management	Owner or manager of the operation and local population.
Moment in which it is included	From the first year

2.3. Flora

The ground has never been carved so it is completely unspoilt. The vegetation cover that has been formed is composed of wild, compound grasses and a large number of tropical species. On the other hand, there is a savanna forest that extends along the estate, and is connected to the rest of the African savannah, without interruption. Therefore, we will treat the farm as a single unit of vegetation: African savannah and its spontaneous flora.
The impact that will affect the vegetation units is the clearing, clearing and tillage for

the preparation of the land where the orchard will be located. The spontaneous flora has a high recovery capacity, since it is enough to not clear a time for the vegetation to regrow naturally. However, the trees are very difficult to recover because it takes years to reach a good size. Taking into account that only trees that are more difficult to cut, and that previously has taken the measure of leaving a vegetation cover on the roads to avoid erosion, the situation with and without project is the following.

2.3.1. Situation without project

Description	Surface (ha)	Biological value
Savannah of acacias and its spontaneous flora	15	1

The biological value in the situation without project is 1, that is to say 100% since it is a completely virgin land.

2.3.2. Situation with project

Description	Surface (ha)	Biological value
Savannah of acacias and its spontaneous flora	15	0.15

After clearing and tillage, 15 ha of land have lost biological value, although there are still trees in the same orchard and the roads have a permanent vegetation cover. Therefore, the value is reduced to 0.15.

2.3.3. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	Cumulative 3
Synergy (S)	Synergistic 3
Moment (M)	Medium Term 2
Persistence (P)	Permanent 3
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	Newspaper 3
Continuity (C)	Not Continuous 1

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$\mathrm{I} = 3 + 2 \times 3 + 2 + 2 \times 3 + 2 \times 1 + 2 \times 1 + 1 + 2 \times 3 + 3 = 28$$

Standard Incidence:

$$\mathrm{I_S} = \frac{\mathrm{I} - \mathrm{I_{mín}}}{\mathrm{I_{máx}} - \mathrm{I_{mín}}} = \frac{28 - 14}{42 - 14} = 0{,}5$$

2.3.4. Magnitude

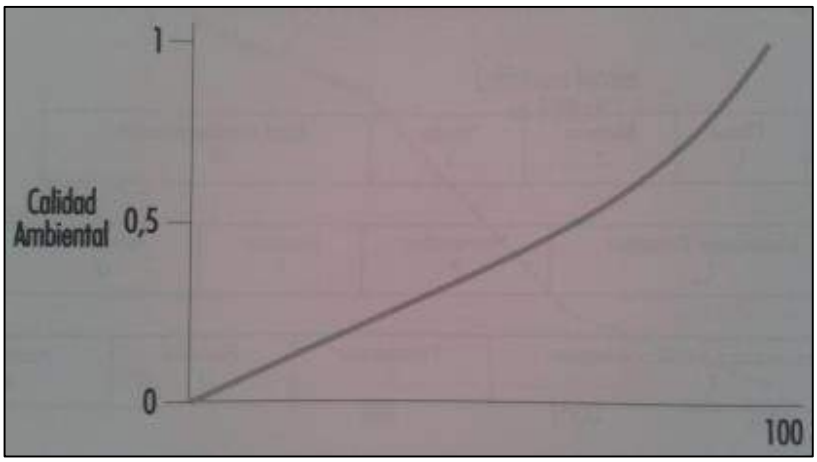

Imagen 2: Transformation function for impact on flora. (Source:)

$$I_{sin}\,(\%) = [\Sigma(Supi \times Vi)]/Sup_{total} = [(15 \times 1))/15] \times 100 = 100\% \rightarrow 1$$

$$I_{con}\,(\%) = [\Sigma(Supi \times Vi)]/Sup_{total} = [(15 \times 0'15)/15] \times 100 = 15\% \rightarrow 0'15$$

$$\text{Magnitud} = \mathrm{I_{sin}} - \mathrm{I_{con}} = 1 - 0{,}15 = 0{,}85$$

2.3.5. Evaluation

This is a high impact, although compatible. Therefore, after performing the work of preparation of the land, the medium is able to return to a suitable environmental situation in the medium term.

$$V = I_S \times \text{Magnitud} = 0{,}28 \times 0{,}85 = 0{,}238$$

2.3.6. Applied Measures

A zone of planting of tree species, with a high conservation value, will be established as compensatory measure. Specifically the edges of the farm and the edges of the vehicular passageways will be used. In addition, trees will be planted regularly and spread over 15ha of the farm reserved for the production of organic matter. In this way old trees will be replaced, and tree density and diversity will be increased and maintained.

Tabla 5: Measures applied to impact on flora. (Own elaboration)

Protective measures	
Impact to which it is directed	Loss of vegetation and tree diversity
Definition of the measure	Planting trees of various species
objective	Increase the conservation value of the farm in its entirety.
Effectiveness	Very high
Description of the measure	Plantation of diverse species of trees of high conservation value, in the edges of the farm and of the roads for vehicles, and in the forest of the finca, to increase its density and tree diversity.
Entity responsible for its management	Owner or manager of the operation.
Moment in which it is included	From the first year

2.4. Landscape

This factor quantifies the impact of the visual impact of the project on the landscape. The corresponding transformation function is applied to find the incidence, and then the environmental quality of the modified landscape.

2.4.1. situation without project

The impact of the visual incidence would be null, as no landscape element of the estate was modified. Being a completely virgin land, the value of the visual incidence without project is 0.

Description	Surface (ha)	Value
Visual Incidence	15	0

2.4.2. Situation with project

In this case, the impact of the visual incidence would be high, since it would transform the landscape of the farm completely. In this case, the land passes from a virgin state to a state of exploitation. Taking into account the corrective measures to be taken in the other areas, the visual impact on the farm is 0.75.

Description	Surface (ha)	Value
Visual Incidence	15	0.75

2.4.3. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	Cumulative 3
Synergy (S)	No Synergistic 1
Moment (M)	Long Term 1
Persistence (P)	Permanent 3
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	Newspaper 3
Continuity (C)	Continius 3

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$I = 3 + 2 \times 3 + 1 + 2 \times 3 + 2 \times 1 + 2 \times 1 + 3 + 2 \times 1 + 3 = 28$$

Standard Incidence:

$$I_S = \frac{I - I_{mín}}{I_{máx} - I_{mín}} = \frac{28 - 14}{42 - 14} = 0{,}5$$

2.4.4. Magnitude

The valuation indicator is first made and then the transformation function is used:

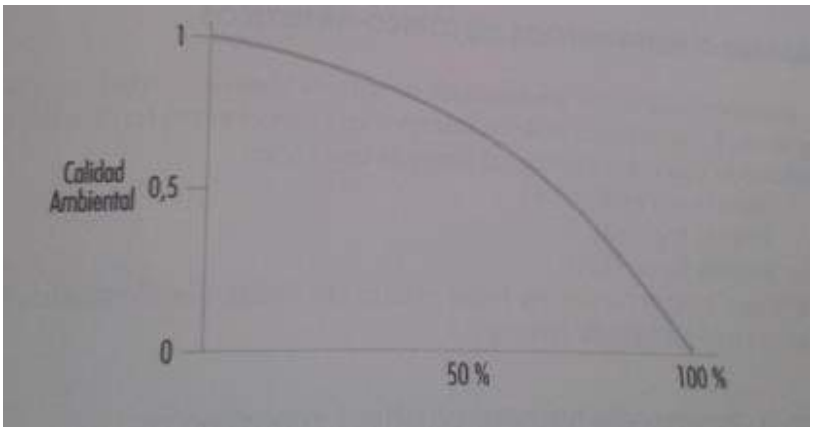

Imagen 3: Transformation function for impact on landscape.

$$I_{sin}\,(\%) = [\Sigma(Sup_i * V_i)]/Sup_{total} = [(15 \times 0))/15] \times 100 = \% \rightarrow 1$$

$$I_{con}\,(\%) = [\Sigma(Sup_i * V_i)]/Sup_{total} = [(15 \times 0{,}75)/15] \times 100 = 75\% \rightarrow 0{,}5$$

$$Magnitud = I_{sin} - I_{con} = 1 - 0{,}5 = 0{,}5$$

2.4.5. Evaluation

$$V = I_S \times Magnitud = 0{,}28 \times 0{,}5 = 0{,}14$$

The Impact Value is moderately high, although compatible with the expected activity. Even so, measures will be taken not to disturb the landscape quality of the area.

2.4.6. Applied Measures

A perimeter vegetable screen will be provided to the farm, in order to reduce the impact caused by the visual intrusion. This measure is complemented by others and established as the planting of trees on the edges of the farm. In this case, special care should be taken to achieve adequate density in those areas where the visual incidence is greater.

Tabla 6: Measures applied on landscape impact. (Own elaboration)

Protective measures	
Impact to which it is directed	Visual Incidence
Definition of the measure	Creating a natural visual display
objective	Decrease visual intrusion
Effectiveness	high
Description of the measure	Maintenance of an adequate density of trees planted on the edges of the farm, theft and roads to avoid visual intrusion, especially in areas with greater visual incidence.
Entity responsible for its management	Owner or manager of the operation.
Moment in which it is included	From the first year

2.5. Socio - economic

For this particular factor, the impact of social acceptability on the project is evaluated. The environmental impact indicator to be taken into account is 2143. Social acceptability of the project: society's perception of the project and attitude towards it (percentage of population against the project and number of allegations presented). In the area of the estate is settled an Anuak population, from which they take advantage of the wood and the wild plants. During the previous phase of the project, it was possible to verify that this population looks forward to the beginning of the project and will increase the labor contracting in the area. Therefore, no allegations or claims have been filed to the project, on the contrary, acceptance is very high.

2.5.1. Situation without Project

Description	Habitants	Value
Population against the project	Less than 1000	0

2.5.2. Situation with Project

Description	Habitants	Value
Population against the project	Less than 1000	0

No one in the area has opposed the project, either formally or within communities.

2.5.3. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	No Cumulative 1
Synergy (S)	No Synergistic 1
Moment (M)	Short Term 3
Persistence (P)	Temporal 1
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	In the Newspaper 1
Continuity (C)	Discontinued 1

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$I = 3 + 2 \times 1 + 3 + 2 \times 1 + 2 \times 1 + 2 \times 1 + 1 + 2 \times 1 + 1 = 18$$

Standard Incidence:

$$I_S = \frac{I - Imín}{Imáx - Imín} = \frac{18 - 14}{42 - 14} = 0{,}143$$

2.5.4. Magnitude

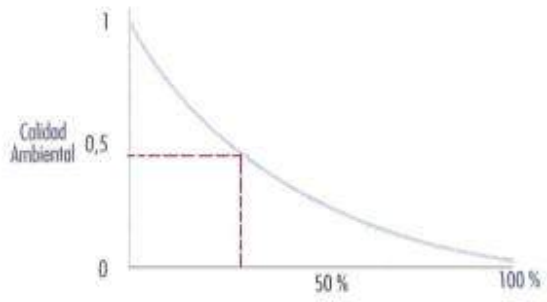

Imagen 4: Transformation function for impact on the socio-economic environment.

La constante K depende del tipo de ámbito de referencia y es como sigue:

K	Tipo de ámbito de referencia
1	Suelo rústico
5	Al menos una parte del ámbito afecta a una población de menos de 1.000 habitantes
10	Al menos una parte del ámbito afecta a una población entre 1.000 a 10.000 habitantes
50	Al menos una parte del ámbito afecta a una población de más de 10.000 trabajadores

Imagen 5: Values of K according to the type of scope of reference.

In this case a constant K is used which depends on the reference range. In this case, it is a rustic soil K = 1, so the incidence without and with project is:

$$I_{sin}\,(\%) = [\Sigma(Sup_i * V_i)] \times K/Sup_{total} = [(15 \times 0))/15] \times 100 = 0\% \rightarrow 1$$

$$I_{con}\,(\%) = [\Sigma(Sup_i * V_i)] \times K/Sup_{total} = [(15 \times 0)/15] \times 100 = 0\% \rightarrow 1$$

$$Magnitud = I_{sin} - I_{con} = 1 - 1 = 0$$

2.5.5. Evaluation

$$V = I_S \times Magnitud = 0{,}14 \times 0 = 0$$

The project is well received by the local population and the impact is very positive. In order to maintain this good image and continue to count on the support of the local population, some measures must be taken.

2.5.6. Applied measures

To compensate the local population for the loss of land from which to obtain timber, and other inputs important to their economy, priority will be given to hiring staff for agricultural work. In addition, they will be integrated into the agricultural education program in which this project is framed and fruit trees will be promoted by the local inhabitants for their use as a source of income or food of their own.

Tabla 7: Measures applied to impact on the socio-economic environment. (Own elaboration)

Protective measures	
Impact to which it is directed	Social acceptance
Definition of the measure	Labor recruitment and educational offer
objective	Maintain good social acceptance of the project
Effectiveness	Very high
Description of the measure	Priority for the local population in the hiring of personnel. Inclusion in agricultural courses. Promotion of good agricultural practices and diversification of sources of income.
Entity responsible for its management	Owner or manager of the operation and local inhabitants.
Moment in which it is included	From the first phase of the project

2.6. Hydrology

The horticultural exploitation that is intended to be implemented brings with it a high consumption of water, becoming necessary 87,5 mm in the month of January for crops of long cycle seeded in September. On average, the amount of water provided in a month is 45 mm.

The hydrological impact of the project is relatively important, since in addition to being a large size for an orchard, during the dry season water is a scarce resource, the rivers dry and only the larger ones maintain adequate flow, among them The Baro. The average flow measured in the town of Gambella of this during the year is 13.2 km ^{3}

2.6.1. Situation without Project

Description	km ^{3}	Value
Baro River Water Use	0	0

2.6.2. Situation with Project

With the project at full capacity, it is expected to consume an average of 45 mm per month over the entire surface of 15ha, ie an annual total of 0,000081km $^{3.}$

Description	km ^{3}	Value
Baro River Water Use	0,000081	6x10 $^{-6}$

2.6.3. Incidence

Attributes	Characterization
Immediacy (i)	Direct 3
Accumulation (A)	No Cumulative 1
Synergy (S)	No Synergistic 1
Moment (M)	Short Term 3
Persistence (P)	Temporal 1
Reversibility (R)	Reversible 1
Recoverability (Rc)	Recoverable 1
Periodicity (Pr)	In the Newspaper 1
Continuity (C)	Discontinued 1

$$I = i + 2 \times A + M + 2 \times P + 2 \times R + 2 \times Rc + C + 2 \times S + Pr$$

$$I = 3 + 2 \times 1 + 3 + 2 \times 1 + 2 \times 1 + 2 \times 1 + 1 + 2 \times 1 + 1 = 18$$

Standard Incidence:

$$I_S = \frac{I - I_{mín}}{I_{máx} - I_{mín}} = \frac{18 - 14}{42 - 14} = 0{,}143$$

2.6.4. Magnitude

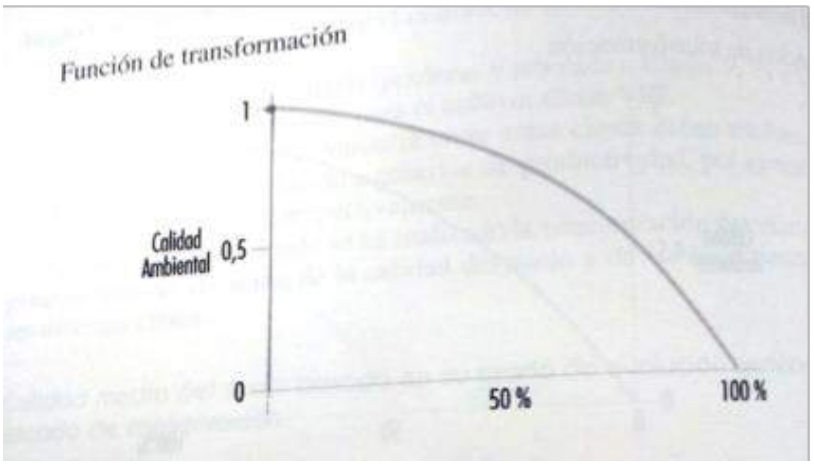

Imagen 6: Transformation function for hydrological impact.

With the transformation function and with the percentage of used flow of the river Baro, we obtain the indicator of environmental quality

$$I_{sin}\,(\%) = [\Sigma(Supi * Vi)]/Sup_{total} = [(15 \times 0))/15] \times 100 = 0\% \rightarrow 1$$

$$I_{con}\,(\%) = [\Sigma(Supi * Vi)]/Sup_{total} = [(15 \times 6.10^{-6})/15] \times 100 = 6.10^{-4}\% \rightarrow 0{,}99$$

$$Magnitud = I_{sin} - I_{con} = 1 - 0{,}99 = 0{,}01$$

2.6.5. Evaluation

$$V = I_S \times Magnitud = 0{,}14 \times 0{,}01 = 0{,}0014$$

It is an almost insignificant impact. However, steps will be taken to prevent it from becoming a problem in the future.

2.6.6. Applied measure

Special care will be taken with the use of water. It will avoid waste, as well as its unnecessary use, either because it has rained before scheduled irrigation or for any

other reason. For this, the compensated drain was chosen as irrigation medium. This way you can irrigate in a precise and homogeneous way the entire farm.

Tabla 8: Measures applied to impact on hydrology. (Own elaboration)

Protective measures	
Impact to which it is directed	Water use
Definition of the measure	Efficiency in water use
objective	To be as efficient as possible in the use of water and to reduce the impact on the Baro River
Effectiveness	Half
Description of the measure	Use of precise irrigation systems, paying special attention to their management to not irrigate when it is not necessary
Entity responsible for its management	Owner or manager of the operation
Moment in which it is included	From the first phase of the project